

CHAPTER
1

Introduction

Historical perspective	3
Overcoming the limitations of conventional brackets	4

VISIT...

LANZAROTE
Caliente.COM

The Tip-Edge® (TP Orthodontics Inc., La Porte, Indiana, USA) bracket was invented by Dr Peter Kesling to introduce differential tooth movement within an edgewise based bracket system.¹⁻³ As its name suggests, Tip-Edge combines an initial degree of tooth tipping, which greatly facilitates tooth movement, prior to 'edgewise' precision finishing.

Based on extensive clinical experience, it is the belief of the author that Tip-Edge is the most significant innovation in fixed appliance orthodontics since the original edgewise bracket.^{4,5} While essentially a 'straight-wire' appliance itself, in terms of preadjusted bracket specification and elimination of looped archwires and finishing bends, it overcomes the fundamental limitations of today's popularly accepted straight-wire systems, and opens up new horizons in fixed appliance orthodontics. Now, with the advent of the 'Plus' system, the need for auxiliary springs during the root uprighting and torquing phase has been eliminated, so making Tip-Edge significantly more operator friendly.

Although the title of Tip-Edge was originally coined as a nickname, it has since become adopted worldwide, in preference to the official and more formal title of Differential Straight-Arch® (TP Orthodontics Inc., La Porte, Indiana, USA) technique.

Historical perspective

Recognition is rightly given to Dr Edward Angle as the father of fixed appliance orthodontics (Fig. 1.1). The 'Edgewise' bracket, which he invented as long ago as 1925, has been the mainstay of fixed appliance practice ever since.⁶ It provides the neatest way of achieving three-dimensional root control and was, in its day, years ahead of its time. Time moves on, however, and many of the intrinsic faults and limitations of edgewise based systems have since been acknowledged, but incompletely addressed.

It is little known that Angle himself appreciated that tooth movement was facilitated by allowing a tooth to tip. Previous to his edgewise bracket, he illustrated a crude piston device for retracting a canine into an extraction space, propelled by a threaded screw.⁷ The attachment to the band incorporated a

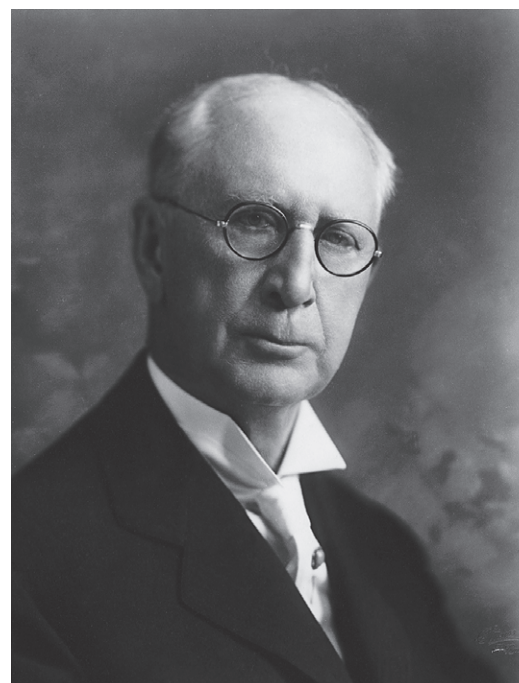


Fig. 1.1 Dr Edward Angle.

primitive hinge to allow distal crown tipping of the tooth being moved. Unfortunately, he had no means of subsequent root uprighting. Significantly, shortly after he conceived the edgewise bracket, he adopted his well known non-extraction treatment doctrine, to which his edgewise bracket was best suited, although a large number of his results, as history shows, proved to be unstable.

While several orthodontists of the postwar period reintroduced the concept of extractions in search of greater stability, in crowded or severe discrepancy cases, Dr Raymond Begg (Fig. 1.2) was notable in evolving a different bracket system. The resulting Begg technique marked a radical departure from conventional treatment mechanics.^{8,9} In fact, the Begg bracket was itself a modification of Angle's earlier 'ribbon arch' bracket. Its adoption was designed to overcome one of the prime disadvantages inherent in all edgewise systems, which Begg had



Fig. 1.2 Dr Raymond Begg.

previously recognized. This is that every tooth is subject to mesio-distal bodily control from the moment of archwire engagement, thus increasing resistance to retraction.¹⁰ By allowing teeth to tip freely during the initial stages of tooth translation, Begg introduced an entirely new sequence of tooth movement, tipping the crowns into their corrected positions before uprighting the roots as a later procedure.

It would be fair to say that Raymond Begg startled the orthodontic world in a big way. The previously unrecognized sheep farmer from Australia, who had nonetheless been a highly favoured pupil at the Angle school of orthodontics, was able to show cases treated with a speed undreamed of with edgewise type appliances, and with a flexibility of tooth movement that enabled ultralight forces to be used. This in turn made fewer demands upon anchorage.

From the time it first appeared in the early 1960s, the Begg appliance aroused keen interest but, perhaps inevitably, was fiercely opposed by established orthodontic thinking. Much of this was no doubt provoked by the safeguarding of vested interests and the professional reputations of many. At the same time, Begg's appliance, exciting as it was, had inherent problems. Root recovery, sometimes from extreme angles, could be less than reliable, while accurate molar control and buccal segment torque were denied by the inability to use rectangular archwires.

In retrospect, Begg undoubtedly stimulated conventional edgewise thinking towards lighter forces and shorter treatment times. This has since been much aided by advances in metallurgy and reduction of friction between brackets and archwires, a continuing quest which is still much in evidence today. He was also the first to demonstrate the clinical potential of differential tooth movement.

Without question, a most notable innovation in bracket design, which continues to dominate modern orthodontics, came with the advent of the 'straight-wire' bracket system, pioneered by Dr Lawrence Andrews in the late 1970s.¹¹⁻¹³ This was a direct development of the edgewise design, and introduced the concept of a preadjusted appliance. By incorporating in-out adjustments and finishing angulations of tip and torque into the bracket itself, individualized finishing prescriptions for each tooth became available, based on Andrews' own research. The edgewise operator was thus relieved of the necessity of placing finishing torque into the rectangular archwires in all cases, let alone all those second order 'beautifying bends' required to achieve correct mesio-distal root angulations. Such new technology, essentially simple as it was, set higher standards for case finishing, as previously defined by Andrews' six keys to normal occlusion.¹⁴ This was further to hasten the decline of the Begg appliance, which boasted no self-limiting prescription finish and was, like edgewise, a lot more challenging to manage in terms of wire bending (Fig. 1.3).

Strictly, the term 'straight-wire appliance' refers to the Andrews version, originally patented to the former 'A' Company, incorporating Andrews' torque-in-base bracket prescriptions. Subsequent alternative prescriptions appeared, notably the Roth 'modified edgewise'. Following the expiry of the patent, it was predictable that other manufacturers would follow the principle, if not the detail, giving us the plethora of so-called straight-wire brackets that we have today. The Tip-Edge Plus bracket, at the time of writing, remains patented to TP Orthodontics.

Overcoming the limitations of conventional brackets

The undoubted popularity of straight-wire systems should not blind the free-thinking orthodontist to the many limitations that the very design of such brackets imposes in everyday clinical use. Although simplicity of archform makes the orthodontist's life easier, and individualized bracket prescription facilitates a better detailed finish, it has long been acknowledged that moving teeth apex-first generates maximum anchorage resistance. Secondly, the control of third order torque is primitive, in that torque transmitted by an active rectangular archwire inevitably provokes unwanted reciprocal torque reactions in adjacent teeth. Finally, the torque prescription 'written in' to each bracket may not be achieved in clinical practice, due

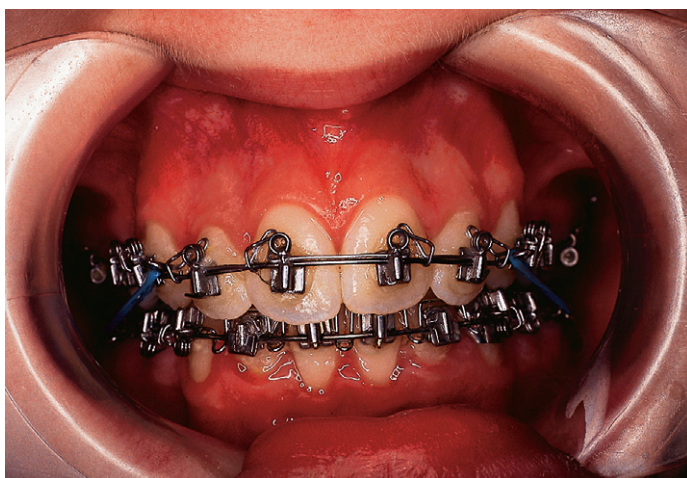


Fig. 1.3 The Begg appliance was intricate and lacked buccal segment torque. Note the auxiliary uprighting springs and spurs, correcting tip and anterior torque respectively.

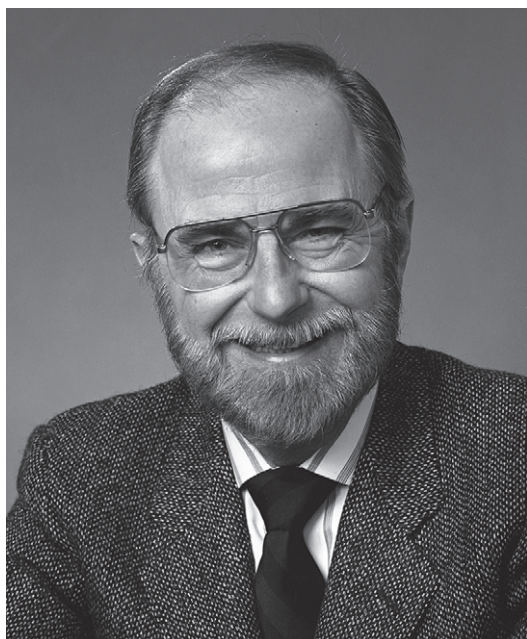
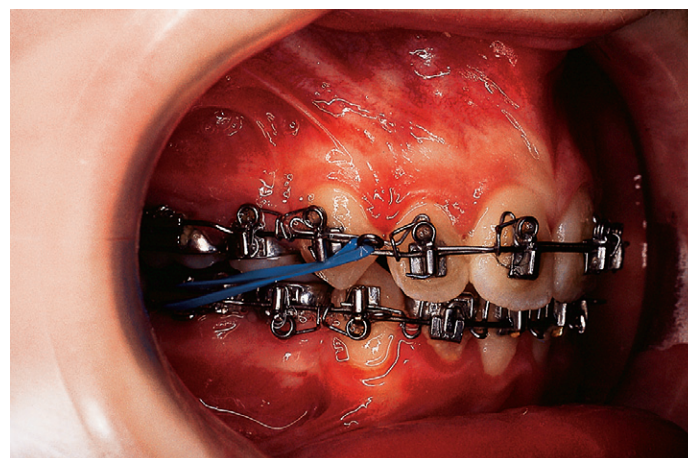


Fig. 1.4 Dr Peter Kesling.

to the 10 degrees of 'torque slop' present when the commonly used $.019 \times .025$ inch archwire is fitted within a $.022 \times .028$ inch bracket slot.¹⁵ Inevitably, this will result in some degree of undertreatment, unless compensated by an exaggerated torque prescription in the bracket, or torque enhancement in the archwire.

It was primarily to address the first of the above three limitations that Dr Peter Kesling (Fig. 1.4) modified a single straight-wire bracket, to create Tip-Edge. The technique was first introduced at the Kesling-Rocke Orthodontic Center (Westville,

Indiana, USA) in 1986. Although the modification to the bracket is essentially simple, confined largely to removing two diagonally opposed corners from the rectangular archwire slot, the effects are far reaching; so far reaching, in fact, that much established thinking and practice becomes challenged as obsolete by the evidence of clinical results, and particularly by the relative ease with which these can be obtained.

None of the foregoing is intended to deny the continuing excellence of the straight-wire appliance in terms of simple alignment, which was, after all, the purpose for which Angle designed his edgewise bracket in the first place. Indeed, in such cases, Tip-Edge may confer little or no advantage. However, the more difficult the case in terms of tooth movement, whether with extractions or non-extraction, the greater the benefit of Tip-Edge becomes. Why is this? Essentially, differential tooth movement makes the translation of teeth into their finishing positions so much easier, employing only very light forces. As will be demonstrated in later chapters, reduction of large overjets and the attainment of Class I buccal segment occlusion is greatly simplified, consuming little anchorage, while the correction of overjets and increased overbites early in treatment contributes to shorter overall treatment times.^{16,17}

While Tip-Edge quickly established itself among many previous Begg users as a rapid tooth mover, it was, in its original form, a round wire technique. Therefore, although each bracket contained an individualized 'straight wire' prescription, the potential of the bracket could not be fully exploited, since only tip correction was self-limited. Neither could effective torque control be applied readily to the buccal segments. Such initial shortcomings were overcome with the discovery, in 1992,¹⁸ that the use of passive full thickness rectangular archwires would impart not only accurate molar control, but would allow a second order uprighting mechanism to express third order torque, concurrent with tip, during the root uprighting

finishing phase. The result was a truly preadjusted appliance, capable of automatic recovery from up to 14 degrees of torque discrepancy from either direction, without significant archwire deflection, and therefore without any unwanted torque reactions against adjacent teeth. Now, the Plus bracket builds further on the Tip-Edge principle by deriving its tip and torque forces from light nickel–titanium auxiliary archwires, instead of the previously used Side-Winder springs.

While it is commonly believed that the superior treatment ability of Tip-Edge is shown most convincingly in Class II division 1 and Class II division 2 cases, its flexibility of treatment

is appropriate to all malocclusion types. A particular advantage, whatever the case under treatment, is that its root uprighting capability, in the rectangular wire phase, is largely ‘maintenance free’. Essentially this means that the latter half of treatment consists mainly of inspections, rather than archwire checks, entailing a considerable saving in clinical time. Furthermore, Tip-Edge is capable of delivering its finishing prescription more accurately than conventional brackets, without the need for torque adjustment in the archwire. This is because, at the conclusion of treatment, zero tolerance is achieved between bracket and rectangular archwire.

References

1. **Kesling PC.** Expanding the horizons of the edgewise arch wire slot. *American Journal of Orthodontics* 1988; 94:26–37.
2. **Kesling PC.** Differential tooth movement Tip-Edge concept and the differential straight-arch technique. *Journal of Indian Orthodontics* 1988; 19:31–35.
3. **Kesling PC.** Dynamics of the Tip-Edge bracket. *American Journal of Orthodontics* 1989; 96:16–28.
4. **Parkhouse RC.** New thinking with Tip-Edge. *Kieferorthop* 1995; 9:137–142.
5. **Parkhouse RC.** JIOS-Interviews: Dr Richard Parkhouse on Tip-Edge. *Journal of Indian Orthodontic Society* 1992; 23:67–73.
6. **Angle EH.** The latest and best in orthodontic mechanism. *Dental Cosmos* 1929; 71:164–174, 260–270, 409–421.
7. **Angle EH.** Treatment of malocclusion of the teeth, 7th edn. Philadelphia: The SS White Dental Manufacturing Company, 1907.
8. **Begg PR.** Light arch wire technique employing the principles of differential force. *American Journal of Orthodontics* 1961; 47:30–48.
9. **Begg PR.** Choice of bracket for the light wire technique. *Begg Journal of Orthodontic Theory and Treatment* 1962; 1:11–17.
10. **Begg PR.** Differential force in orthodontic treatment. *American Journal of Orthodontics* 1956; 42:481–510.
11. **Andrews LF.** The straight-wire appliance, origin, controversy, commentary. *Journal of Clinical Orthodontics* 1976; 10:99–114.
12. **Andrews LF.** The straight-wire appliance. Explained and compared. *Journal of Clinical Orthodontics* 1976; 10:174–195.
13. **Andrews LF.** The straight-wire appliance. *British Journal of Orthodontics* 1979; 6:124–143.
14. **Andrews LF.** The six keys to normal occlusion. *American Journal of Orthodontics* 1972; 62:296–309.
15. **McLaughlin RP, Bennett JC, Trevisi HJ.** Systemized orthodontic treatment mechanics, 2001. London: Mosby.
16. **Galicia-Ramos GA, Killiany DM, Kesling PC.** A comparison of standard edgewise, preadjusted edgewise, and tip-edge in Class II extraction treatment. *Journal of Clinical Orthodontics* 2001; 35:145–153.
17. **Kesling PC, Rocke RT, Kesling CK.** Treatment with Tip-Edge brackets and differential tooth movement. *American Journal of Orthodontics and Dentofacial Orthopaedics* 1991; 99:387–402.
18. **Parkhouse RC.** Rectangular wire and third order torque: a new perspective. *American Journal of Orthodontics and Dentofacial Orthopedics* 1998; 113:421–430.

Differential tooth movement

Variable anchorage	10
Light forces	10
Root uprighting	12

Differential tooth movement

It is customary, in contemporary fixed appliance orthodontics, to work towards finishing angulations from the outset of treatment. This is because edgewise derived brackets, in common use today, dictate this upon the orthodontist by exerting mesio-distal second order root forces from the time of first engagement with an archwire. The very design of such a bracket therefore imposes a treatment regimen of bodily movement (Fig. 2.1) and with it, over many years, has grown the widespread assumption that this is the way teeth require to be moved.

Yet it has long been recognized, even in classical edgewise therapy, that positioning a root apex toward the direction of pull will generate resistance to tooth movement in response to that force. It was for this reason that Dr Charles Tweed developed the concept of 'anchorage preparation', moving his apices mesially in the mandibular buccal segments by means of second order bends, so as to increase anchorage resistance to Class II elastic traction. Evidently, Dr Tweed was a keen 'outdoor man' familiar with camping. It was therefore natural to him to use the analogy of tent pegs to illustrate his concept, whereby tent

pegs are driven into the ground at an angle, in order to resist the pull of the guy rope (RT Williams, personal communication). Yet today, it seems to have become accepted practice to retract teeth apex first. This is particularly so with straight-wire brackets, which inherently prescribe a distal root angulation to canines during retraction. Similarly, during overjet reduction, engaging a rectangular archwire in pretorqued incisor brackets will induce palatal root torque which, by the simple laws of physics, will greatly increase resistance to the required palatal crown movement.

By complete contrast, a bracket designed for differential tooth movement will not impart root-angulating forces when an archwire is engaged. Instead, the crown will be able to tip in the direction of desired tooth movement, essentially leaving the root apex to trail behind (Fig. 2.2). Obviously, such simple free tipping requires far less force and anchorage than moving the same tooth bodily, although this would in itself amount to incomplete treatment. However, it makes initial decrowding and reduction of big overjets dramatically easy, as well as rapid,

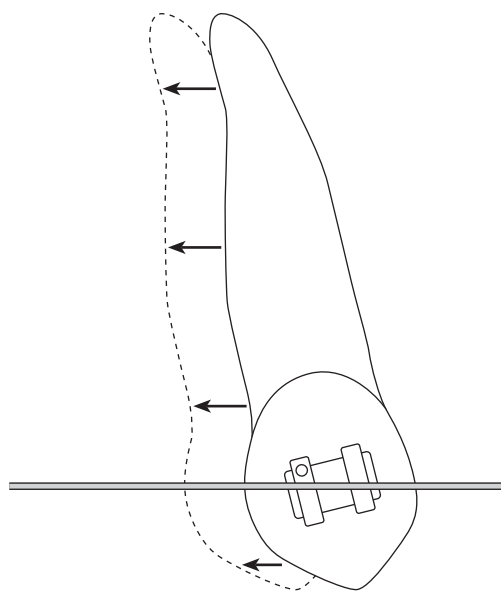


Fig. 2.1 Bodily movement during retraction with an edgewise derived bracket.

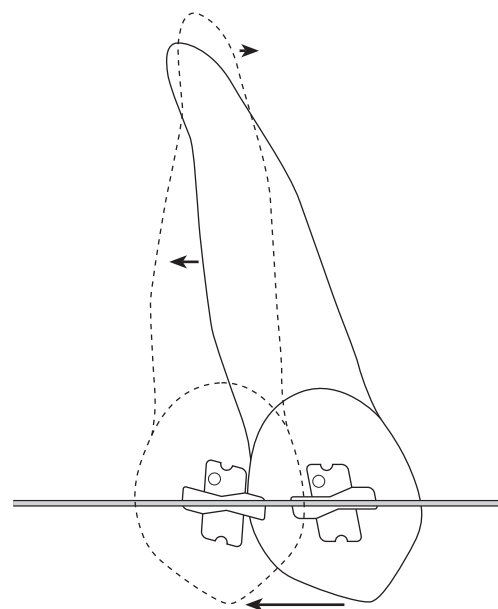


Fig. 2.2 Initial distal crown tipping permitted during retraction with a Tip-Edge bracket.

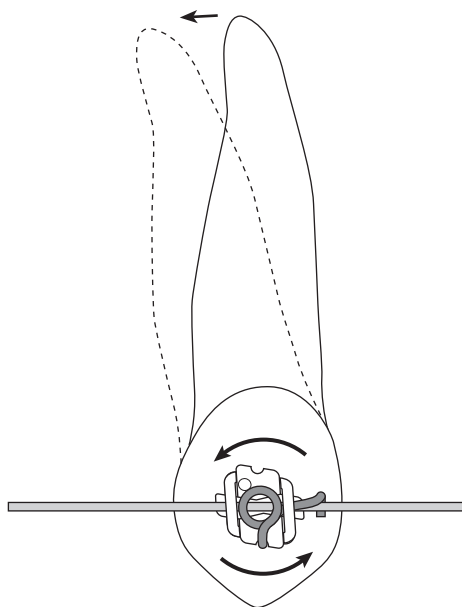


Fig. 2.3 Subsequent root uprighting of a tooth previously tipped during retraction.

together with the attainment of a Class I buccal segment occlusion. Both are achieved early in treatment. This in turn lends stability to the subsequent root uprighting process, both by establishing a strong interdigitation and by bringing the labial segments within the safety of normal lip control, as opposed to the adverse influences of persistent lip trapping.

Of course, this constitutes only half the treatment and the root uprighting, which necessarily follows, may occupy the latter half of the total treatment time (Fig. 2.3). Inevitably, this has anchorage consequences, which will be discussed in Chapter 14. However, it is a striking feature of differential tooth movement that total anchorage requirements, and duration of treatment, seem significantly less than with straight-wire or edgewise systems, particularly in difficult cases.^{1,2} No doubt protagonists for the conventional will wish to challenge this claim, on grounds of lack of scientific evidence; indeed it would be difficult to measure anchorage objectively. Nevertheless, on clinical evidence, it is unarguable.

Why this should be so remains unexplained. Following treatment of any malocclusion, the ideal finish will be the same, whether treated by bodily movement or by differential tooth movement (crown tipping followed by root uprighting); either way, the total change, in terms of individual tooth movement, will be identical. Therefore, one might logically expect the total anchorage demands to be the same in both cases, which evidently they are not.

There is also the clinically observed phenomenon whereby teeth seem to intrude more readily if the roots are allowed angular freedom during the process. The relevance of canine inclination to overbite reduction accounts for much of this, as will be understood from the next chapter.

Variable anchorage

With differential tooth movement, root control of the bracketed teeth can be prescribed by the operator, rather than occurring automatically from first archwire engagement. Of course, root control during the final stages will be obligatory for all teeth for finishing purposes. This process has become much easier with the coming of the Plus bracket, whereby an auxiliary nickel–titanium archwire running through deep tunnels provides overall torque and tip control to all bracketed teeth. However, in the earlier stages of treatment, there are occasions when it can be extremely useful to apply gentle second order root forces to selective teeth. This can be simply done by the addition of an auxiliary (Side-Winder) spring or springs, as was the case with the Rx-1 bracket. This is still possible with the Plus bracket and it is important that it should be. Although it constitutes a small additional clinical procedure, the fact that the orthodontist now has the choice of which roots to control and when, perpetuates the concept of variable anchorage control. This is an option which is not possible with conventional brackets, without resort to more complicated add-ons such as lingual arches, headgears or other anchorage reinforcement. Variable anchorage constitutes an invaluable ‘steerage mechanism’ towards the control of profile and, as we shall see later, correction of centrelines.

As an example, let us consider a lower canine in an extraction case, in which the labial segment has been aligned. When closing the residual extraction space with intramandibular forces, the orthodontist can choose between retraction or protraction. If lingual movement of the labial segment is required, this will readily be achieved simply by pitting bodily movement of the first molars against the lower anteriors, all of which are free to tip – the incisors lingually and the canines distally (Fig. 2.4). Alternatively, if the labial segment position is satisfactory, anterior anchorage can be increased very easily by adding auxiliary springs to the canines (Fig. 2.5). These will induce a distal root force to both lower canines (effectively turning these into ‘straight wire units’) which will buttress the anterior segment against retroclination, so long as the space-closing forces are kept light. The result will therefore be protraction. Auxiliary springs used in this way are known as ‘brakes’. As will be seen in Chapter 10, it is also possible to use springs in an opposite mode in Stage I, to induce lingual tipping of proclined lower incisors, a technique known as ‘Power Tipping’. Finally, Chapter 11 shows how unilateral brakes can correct centrelines during Stage II.

Light forces

It is fundamental to differential tooth movement that all forces should be light. For example, a mere 50 grams of intermaxillary elastic force, bilaterally, will be found quite sufficient for the

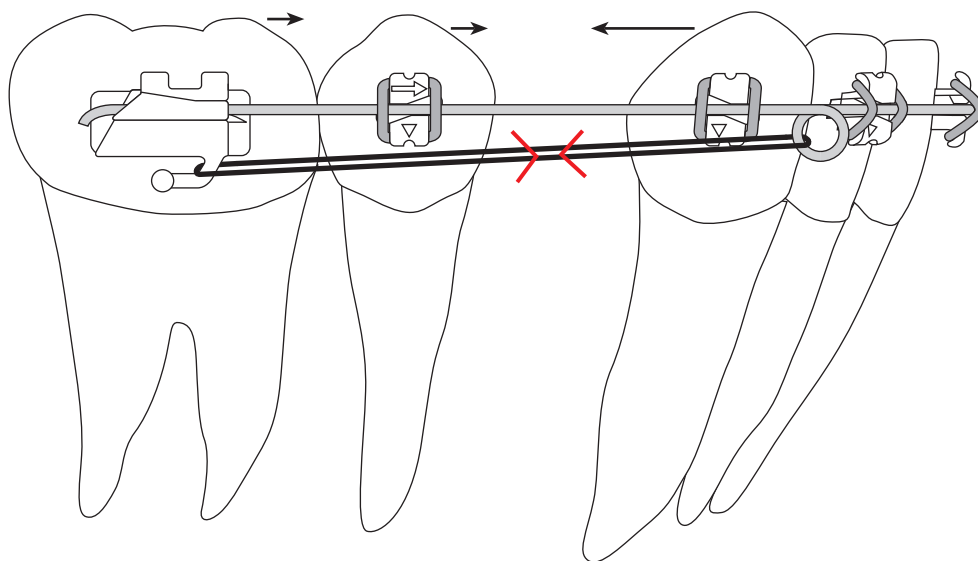


Fig. 2.4 Mechanics of retraction. Six anterior units, free to tip, offer little anchorage resistance when pitted against bodily control of the first molars. The response to intramaxillary space closing forces will therefore be anterior retraction, with minimal loss of anchorage from the molars.

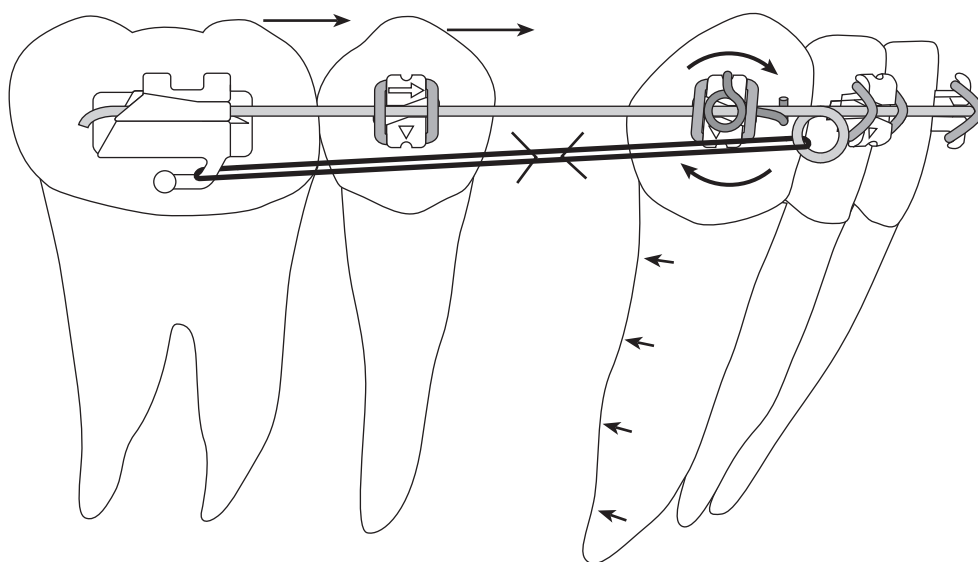


Fig. 2.5 Mechanics of protraction. A similar set-up to that in Figure 2.4, but with Side-Winder™ brakes to canines. These impart root resistance, hence increased anchorage resistance anteriorly. The response to the same space-closing forces will now be protraction of the molars.

reduction of even large overjets. Heavier forces, as will be familiar to users of edgewise type appliances, are unnecessary and likely to be harmful. Not only will posterior anchorage be strained, but the periodontal ligament could be put at risk. This is because differential tooth movement naturally implies a differential periodontal response. Compared with moving a tooth bodily, when the rate of periodontal response will theoretically be uniform down the length of the root (assuming absolute archwire rigidity), tipping a tooth will induce most root movement at the gingival, diminishing towards the apex, which may

even show slight reverse movement. The forces are therefore less evenly dissipated along the root. With light forces, this will not present any hazard.

It is well recognized that root resorption can occur, particularly in susceptible individuals, whatever appliance is used. However, research studies have failed to implicate differential tooth movement and the reader is referred to Beck & Harris,³ who list a comprehensive bibliography. It should also be noted that their particular study involved the Begg appliance, which allowed angles of tip considerably greater than Tip-Edge.

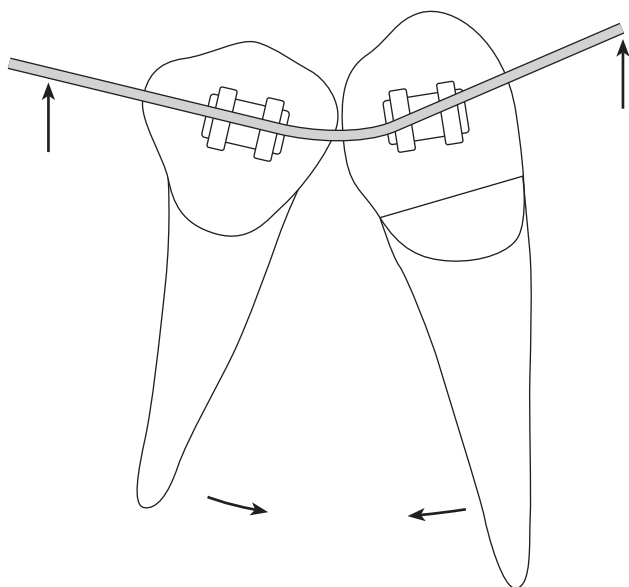


Fig. 2.6 Correcting tipped teeth with conventional brackets induces vertical archwire deflections.

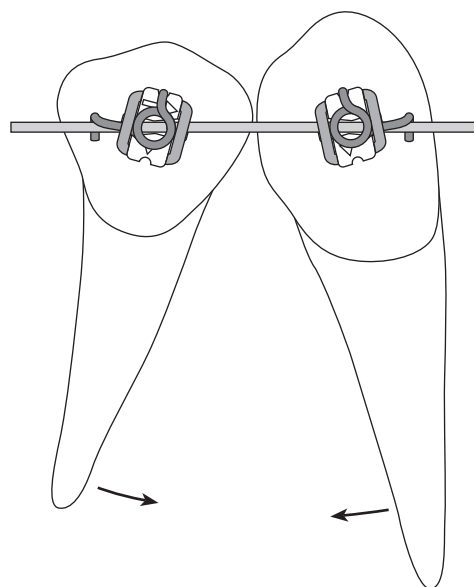


Fig. 2.7 Uprighting teeth with light auxiliary forces causes no vertical deflection of a heavy (passive) archwire, whether with springs or a nickel-titanium auxiliary archwire (as with Plus).

Root uprighting

Before exploring differential tooth movement in detail with Tip-Edge, it is necessary to dispel one further myth. It is popularly believed among students of modern orthodontics that it is 'wrong' to allow teeth to tip during treatment. This is despite the fact that a number of edgewise and straight-wire clinicians have attempted to introduce a modicum of tipping into an otherwise rigid system, in search of greater flexibility and ease of movement. Methods used have included undersized or flexible archwires, narrow brackets or segmental arches. However, such solutions introduce disadvantages and complications of their own, yet are only able to exploit the advantages of differential tooth movement to a minimal extent.

Certainly, no user of conventional brackets would be able to entertain angles of tip that can be accommodated by Tip-Edge. This is hardly surprising, for the simple reason that edgewise and straight-wire brackets offer very poor recovery from tipped angulations. As can be seen (Fig. 2.6), correction of mesio-distal crown tip by engaging the brackets with an active archwire

provokes major vertical consequences, with extrusion of adjacent teeth. While addition of reciprocal gingival 'power arms' may facilitate the uprighting process, vertical archwire deflections will still be present. With Tip-Edge, however, recovery is by the light and progressive action of an auxiliary, while vertical arch stability is maintained by a level and relatively heavy (but passive) archwire. This is illustrated (Fig. 2.7) with easily visualized Side-Winder springs, but the principle is exactly the same with Plus, uprighting with a light nickel-titanium auxiliary archwire beneath an identical main archwire.

Likewise, palatally tipped upper incisors are an unwelcome challenge with conventional appliances. Attempting to correct these by means of an actively torqued rectangular archwire imposes unwanted reciprocal torque reactions on neighbouring teeth, or even the buccal segments, as mentioned in the previous chapter. In this, Tip-Edge innovates by using rectangular wire as a passive platform, to which teeth are torqued entirely individually, again by means of light auxiliary generated forces, and without torque disturbance to adjacent teeth.⁴ This will be fully explained in Chapter 14.

References

1. **Kesling CK.** Differential anchorage and the Edgewise appliance. *Journal of Clinical Orthodontics* 1994; 28:84–92.
2. **Kesling CK.** The Tip-Edge concept: eliminating unnecessary anchorage strain. *Journal of Clinical Orthodontics* 1992; 26:165–178.
3. **Beck NB, Harris EF.** Apical root resorption in orthodontically treated subjects: analysis of edgewise and light wire mechanics. *American Journal of Orthodontics and Dentofacial Orthopaedics* 1994; 105:350–361.
4. **Parkhouse RC.** Rectangular wire and third order torque: a new perspective. *American Journal of Orthodontics* 1998; 113:421–430.

CHAPTER 3

Dynamics of Tip-Edge

From Rx-1 to the 'Plus' bracket	15
The bracket face	16
A 'dynamic' slot	17
Vertical reactions during retraction	18
Frictional resistance	19
Bite opening	19
The Plus base	20
Compatibility of Rx-1 and Plus	23
The first molar tubes	23

From Rx-1 to the 'Plus' bracket

To start the story at its very beginning in 1986, the first Tip-Edge brackets came about by means of a metal saw. The best inventions are frequently the simplest. Dr Peter Kesling's original aim was to make differential tooth movement possible within an edgewise type bracket face. The prototype Tip-Edge brackets were therefore derived from a single .022 inch straight-wire bracket merely by cutting away two diametrically opposed corners from the archwire slot (Fig. 3.1).¹ This resulted in a bracket that enabled the crown to tip in a predetermined direction, whereas with an archwire of full vertical thickness, it would resist tipping in the reverse direction. This was a logical design, since the desired direction of tipping, in routine orthodontic cases, is easy to predict. In general, distal crown tipping is the way the bracketed teeth will naturally want to incline, the main exception being the second premolar in first premolar extraction cases, which will require to tip mesially into the extraction spaces. There are other rare exceptions to this rule, such as where anterior teeth are missing when, if not restoring the spaces, a canine may need to be moved mesially to simulate a lateral incisor, sometimes requiring a contralateral bracket.

Since its introduction, the Tip-Edge bracket (designated Rx-1) has more than proved itself clinically. It is demonstrably

able to tackle difficult malocclusions with an ease of tooth movement, light anchorage and effective overbite reduction, which makes conventional 'bodily movement mechanics' look pedestrian by comparison. Of course, the technique has been progressively refined and improved, in the light of clinical experience, notably when it became able to exploit rectangular wire in an entirely new way (see Chapter 14). Simultaneous uptake of torque and tip, powered by auxiliaries, could now achieve a precision finish. It thus became a truly preadjusted appliance. Such developments along the line, however, were mainly confined to technique and archwire usage. Major developments to the bracket itself did not prove to be necessary. The Rx-1 bracket slot works well. Why, then, the arrival of the Plus bracket in 2003?

As will be understood in Chapter 14, each bracket requires an auxiliary in the final stage in order to deliver a three-dimensional root correction. With the Rx-1 bracket, this inevitably entailed fitting a Side-Winder spring to virtually every tooth, for the duration of the finishing phase. Clearly, this was seen as a disincentive to using Tip-Edge, particularly among edgewise and straight-wire orthodontists. Also, some of the advantages that Tip-Edge had originally enjoyed over straight-wire in the economy of archwires (normally only three in each arch per treatment) had been lost with the coming of the latest generation of nickel-titanium wires. These have been widely adopted in straight-wire techniques to simplify treatment progression, but without hitherto finding a place in Tip-Edge. Might not such advances in technology be able to streamline treatment with Tip-Edge also? Such was the thinking that initiated the development of Plus.

The Tip-Edge Plus bracket is easy to explain. It consists of an Rx-1 face combined with a Plus base. The specification and geometry of the archwire slot is therefore identical to the Rx-1 bracket. However, the innovation of a horizontal 'deep tunnel' in the bracket base completely eliminates Side-Winder springs during the final stage of treatment, allowing synchronous torquing and tipping to be powered inconspicuously by a light nickel-titanium auxiliary archwire, threaded through the tunnels. Clinically this is a much easier process and less prone to error, with obvious benefits to the patient in terms of aesthetics and comfort.

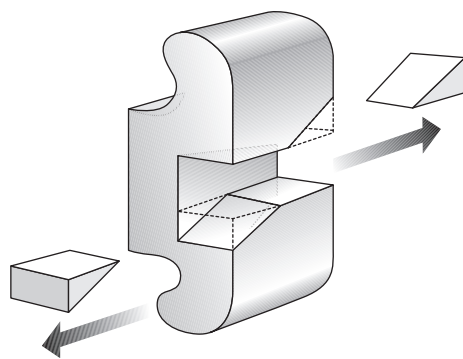


Fig. 3.1 Single straight-wire bracket minus two diametrically opposed wedges = Tip-Edge!

Unlike the Rx-1 brackets, which are manufactured by casting, Plus brackets are metal injection molded. They are also available in ceramic. This is also injection molded, producing a very smooth surface without the need for machining, which might weaken the ceramic. A bonded polymer base ensures safe debonding.

It is a simple matter for a Tip-Edge user to convert to Plus. Essentially the technique in Stages I and II is the same. When setting up Stage III, the main rectangular archwires will be the same, but a single deep tunnel wire in each arch is used instead of all the Side-Winders. Stage III adjustments are easier too, without having to remove all the springs to release the main archwire.

Cases treated with both the Rx-1 and Plus brackets are therefore presented in this book.

The bracket face

Tip-Edge brackets (Fig. 3.2) contain many features already familiar to the edgewise or straight-wire operator, including conventional tie wings, which accept standard elastomeric ligatures. Likewise, bracket identification is by small circular markers at the disto-gingival tie wings of the maxillary anterior brackets, and similarly placed triangular markings for the mandibular anteriors. (The orientation of premolar brackets depends on the desired direction of tipping and is dealt with in Chapter 6.)

The 'cut out surfaces' of the archwire slot form the 'tip-limiting surfaces', which restrict the degree of tipping permitted during tooth translation. The intact surfaces are therefore the 'finishing surfaces', containing the individualized finishing prescription for each tooth. The point at which the tip-limiting and finishing surfaces meet constitutes the central ridge; the opposing central ridges provide vertical control until final finishing and are also the points at which torque is imparted, under the

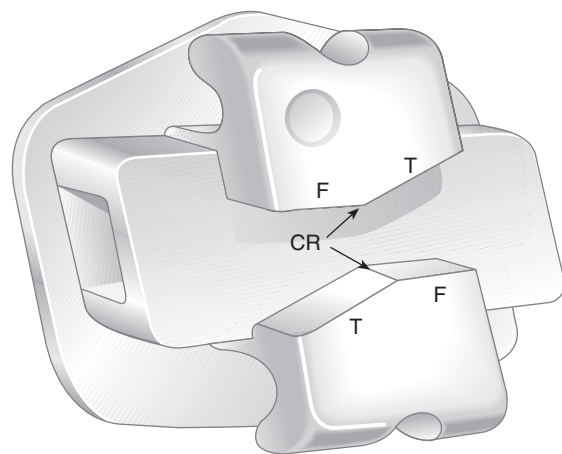


Fig. 3.2 Tip-Edge Plus bracket. CR = central ridge, T = tip-limiting surfaces, F = finishing surfaces.

influence of the uprighting auxiliary, during the final rectangular wire phase. The laterally extended surface lingual to the main archwire preserves rotational control throughout the range of tip permitted by the bracket. This is without detriment to aesthetics, since it is largely concealed beneath the archwire itself. The broader base also provides for a longer deep tunnel, for more effective uprighting later in treatment.

The basic sequence of Tip-Edge treatment is therefore illustrated, showing an upper right canine from its starting position (Fig. 3.3A). During the initial decrowding or overjet reduction,

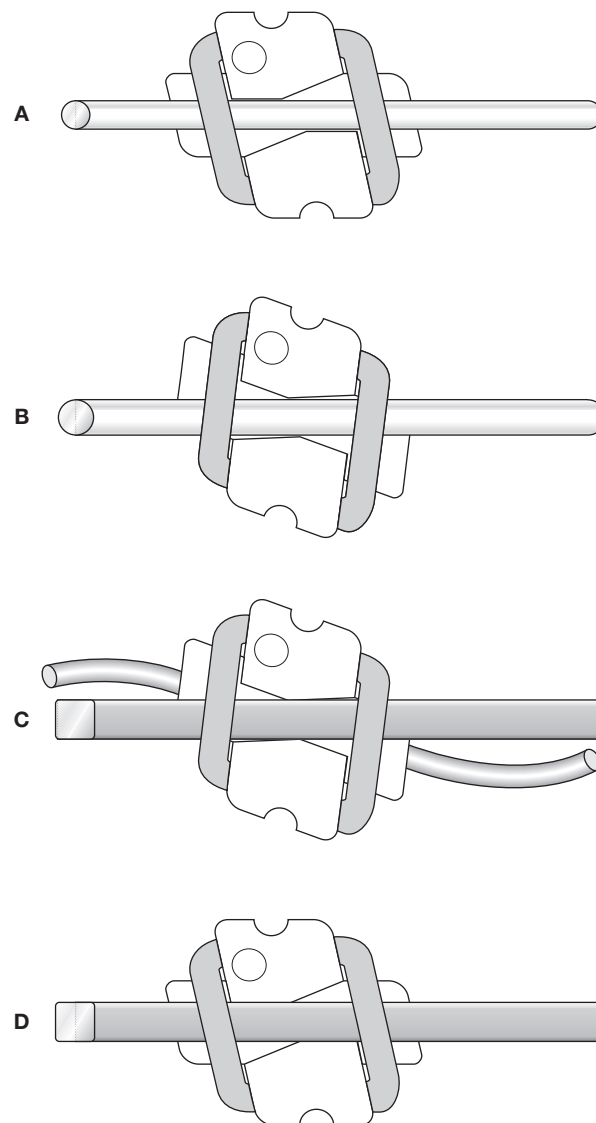


Fig. 3.3 The sequence of differential tooth movement: (A) maxillary right canine at start of Stage I. (B) By end of Stage II, following retraction, the crown will have tipped distally. (C) using a rectangular Stage III archwire, a .014 inches auxiliary nickel-titanium deep tunnel archwire will commence root uprighting. (D) Because the main archwire is rectangular, torque will be achieved automatically with tip correction, until the bracket prescription is expressed. The action is self-limiting.

Table 3.1 Rx-1 and Plus—Single wing Tip-Edge brackets .022 inch archwire slot angulations

	Maximum crown tip during translation	Final crown tip	Final root torque
Maxillary			
Central incisor	20° distal	5°	12°
Lateral incisor	20° distal	9°	8°
Canine	25° distal	11°	−4°
First premolar	20° distal or mesial	0°	−7°
Second premolar	20° distal or mesial	0°	−7°
Mandibular			
Central incisor	20° distal	2°	−1°
Lateral incisor	20° distal	2°	−1°
Canine	25° distal	5°	−11°
First premolar	20° distal or mesial	0°	−20°
Second premolar	20° distal or mesial	0°	−20°

the crown will tip distally into a corrected Class I relationship. Since no root angulating forces are imparted, anchorage will be extremely light during this stage. In an extreme case, the amount of distal crown tip will be limited by the tip-limiting surface (Fig. 3.3B), so that excessive tipping is prevented. The tip-limiting surfaces are angled 25 degrees to the horizontal on canines, 20 degrees on all other bracketed teeth, although in clinical practice such maximum angles of tip will rarely be encountered. Once all crowns are correctly repositioned, a passive rectangular archwire is fitted and an auxiliary nickel–titanium archwire is threaded through the deep tunnels (Fig. 3.3C). This will distalize the root to its prescribed angulation, at which point the uprighting action of the auxiliary archwire will become self-limited by the approximation of the finishing surfaces above and below the main archwire (Fig. 3.3D).

The preadjusted finishing prescription contained within the Rx-1 bracket system is identical in principle to today's straight-wire systems, with tip in the face, torque in the base. The values (Table 3.1) are particular to Tip-Edge (both Rx-1 and Plus). However, alongside the various prescriptions in common use today, they compare most closely to the Roth specification. It should perhaps be mentioned that TP Orthodontics have also produced a Siamese twin version of the Tip-Edge bracket in both .018 and .022 inch formats, perhaps in an attempt to identify more closely with conventional brackets. They are unlikely to appear in Plus format. In the author's opinion, neither can be recommended. A twin Tip-Edge bracket brings no benefits and several disadvantages compared with a single Plus bracket. Apart from poor aesthetics, the extra bulk of such brackets can predispose to occlusal interferences. Furthermore

the internal geometry has been modified, compared with the Rx-1 bracket, placing the Side-Winder spring at some mechanical disadvantage when deriving torque against rectangular wire. Rotational control is often cited as the main benefit with twin edgewise type brackets. However, now that we have the Plus bracket, the deep tunnel auxiliary inherently controls rotations, since the mesio-distal width of the tunnel is itself similar to many twin brackets.

Finally, it has to be said that the very last thing that Tip-Edge needs is an '018 system'! Light forces were pioneered by differential tooth movement and the flexibility required for root movements is continued today by the use of light auxiliary forces. In fact, with Plus, these movements are generated with nickel–titanium archwires of never more than .016 inches diameter. It would be highly undesirable to sacrifice overall control by introducing unwanted flexibility in the passive base archwires, particularly during root uprighting, when the efficiency of the auxiliary forces would be handicapped by working against a narrower torquing platform. This will be more fully understood from the explanation of how Tip-Edge torques in Chapter 14.

A 'dynamic' slot

A curious feature of the bracket design, which is unique to Tip-Edge, is that the archwire slot increases its vertical dimension as the tooth tips. As can be seen (Fig. 3.4), tipping of the tooth crown, during initial translation, alters the axial inclination between bracket and archwire, progressively increasing the

vertical space available for the archwire from .022 to a maximum of .028 inches. How does this happen? The explanation lies in the geometry of the bracket, in which the mesio-distal width of the tip-limiting surfaces slightly exceeds the width of the finishing surfaces. The finishing surfaces therefore extend less than halfway across the face of the bracket, and are at no point directly opposed. Therefore the central ridges, being slightly offset either side of the mid-point, 'open up' the vertical dimension as the bracket tilts.

This feature has considerable clinical significance. Levelling and aligning are greatly assisted, so much so that it is possible to step up from a .016 to a .022 inches stainless archwire in a single move. In this context, it should also be mentioned that interbracket distance is far greater than with any conventional twin type bracket as, with Tip-Edge, the interbracket span is effectively the distance between the central ridges. No less significant, and relevant to later chapters, the dynamic slot makes possible an entirely new means of torque delivery, when the vertical slot dimension is closed down by an auxiliary, against a rectangular archwire, to produce a three-dimensional precision finish.

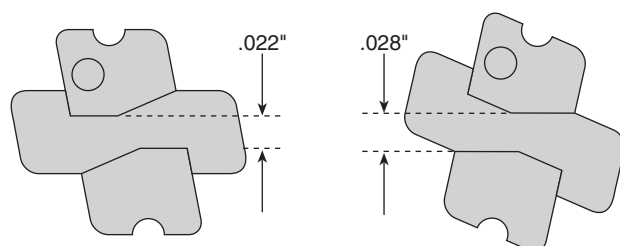
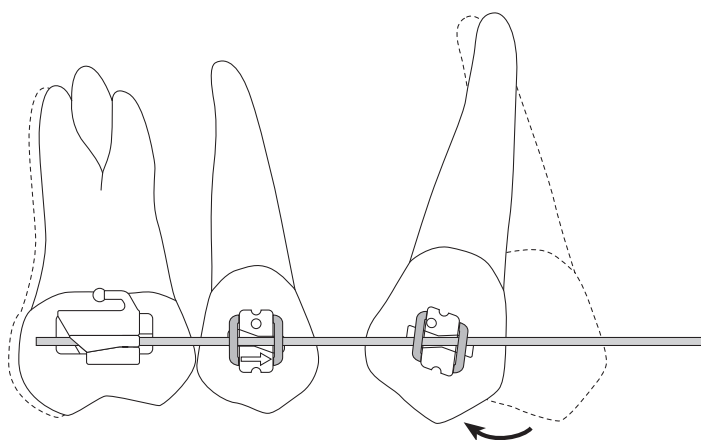


Fig. 3.4 The 'dynamic' Tip-Edge archwire slot increases its vertical archwire space as the tooth tips during initial translation.



Vertical reactions during retraction

Particularly during canine retraction along an archwire, when using full arch mechanics with edgewise or straight-wire brackets, there is a well recognized tendency to produce adverse vertical reactions. This is because such brackets compel the tooth being retracted to move bodily (Fig. 3.5). By the simple laws of physics, the resistance to retraction offered by the root will tend to tip the crown distally, causing some flexion in the archwire. This will in turn tend to extrude the labial segment and intrude the buccal segments, hence the so-called 'roller coaster' effect.

Because differential tooth movement leaves the apex behind, crown retraction carries no vertical consequences (Fig. 3.6), so that vertical 'round tripping' of the anteriors is avoided. There must, of course, be vertical implications later along the line, when the roots are eventually uprighted; however, by this stage

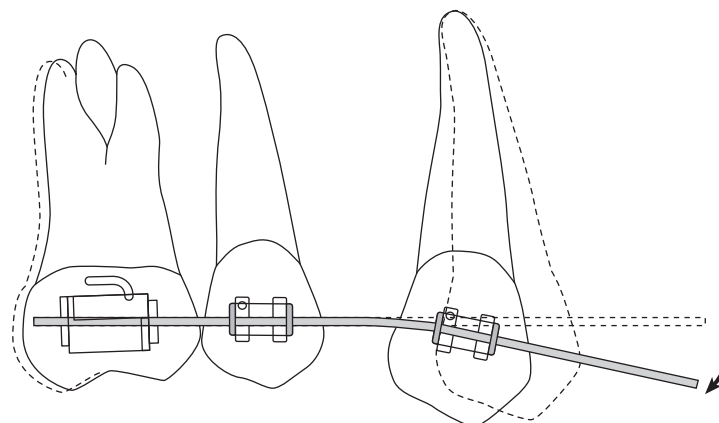


Fig. 3.5 Retraction of a canine with conventional brackets has vertical consequences, which may extrude the incisor segment.

Fig. 3.6 Retraction with Tip-Edge has no extrusive effect.

the patient will be in heavier archwires and protected by an already established interarch relationship.

Frictional resistance

In modern orthodontics, means are constantly being sought to reduce friction between brackets and archwire. Differential tooth movement largely sidesteps this problem, for reasons stemming from the previous paragraph. The apical resistance generated when retracting a tooth bodily is the main culprit in causing binding between bracket and archwire. By contrast, leaving the apex behind will eliminate binding, particularly with a bracket that increases its vertical slot space as it retracts. When the root finally needs uprighting, the crown will already have been corrected and is, therefore, stationary relative to the archwire.

An in-house study of kinetic friction carried out by TP Orthodontics² compares conventional brackets (of its own manufacture) with Tip-Edge at various angles of tip, which convincingly illustrates the different frictional consequences, in the manner in which Tip-Edge brackets are intended to be used clinically.

An additional point to be considered must be friction due to the elastomeric modules. However, it should be noted that,

with free-sliding mechanics, the archwire will frequently move distally with the anterior teeth being retracted, particularly during overjet reduction. Interestingly, self-ligating Tip-Edge brackets have been tried clinically and found to confer no observable clinical benefit to the speed with which crowded teeth unravel. A likely reason is the large interbracket span and increased vertical space within the Tip-Edge archwire slot, both of which are helpful in allowing vertical play within each bracket. Therefore, any unresolved stresses between the archwire, elastomeric ligature and bracket, will be more readily dispersed by the vertical archwire movements permitted within the brackets when the patient eats.

Bite opening

Early bite opening is one of the key reasons why differential tooth movement so frequently demonstrates a reduction in treatment times, particularly in deep bite cases. Edgewise type brackets, used with full archwires, are unable to intrude incisor segments until the canine root angulations are corrected, which in turn delays overjet reduction. A straight-wire bracket exacerbates this problem (Fig. 3.7) by prescribing a greater distal root inclination, which requires to be achieved clinically before the curve of Spee can be levelled. A segmental arch approach can

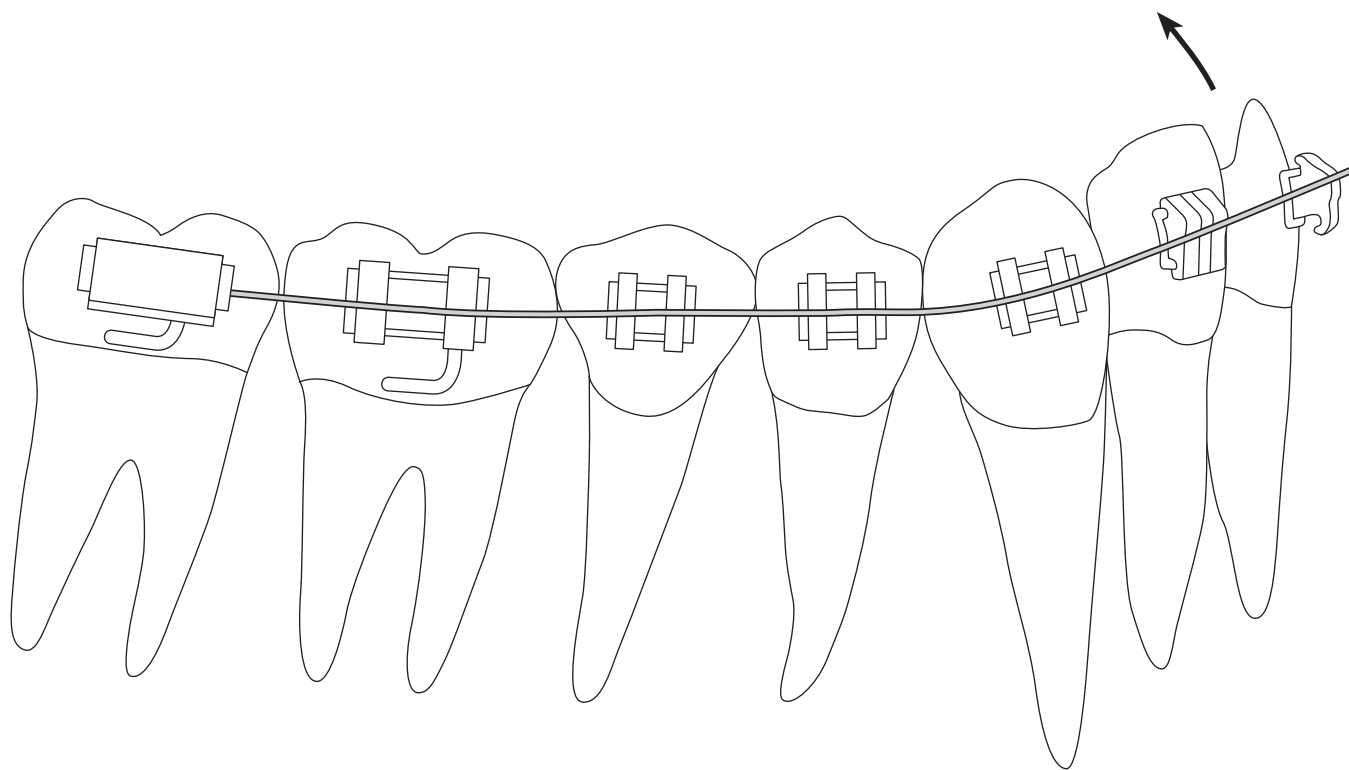


Fig. 3.7 A mesial canine apex has vertical implications with full archwires in conventional brackets: anterior overbite may be increased and its reduction will be delayed until the canine angulation is corrected.

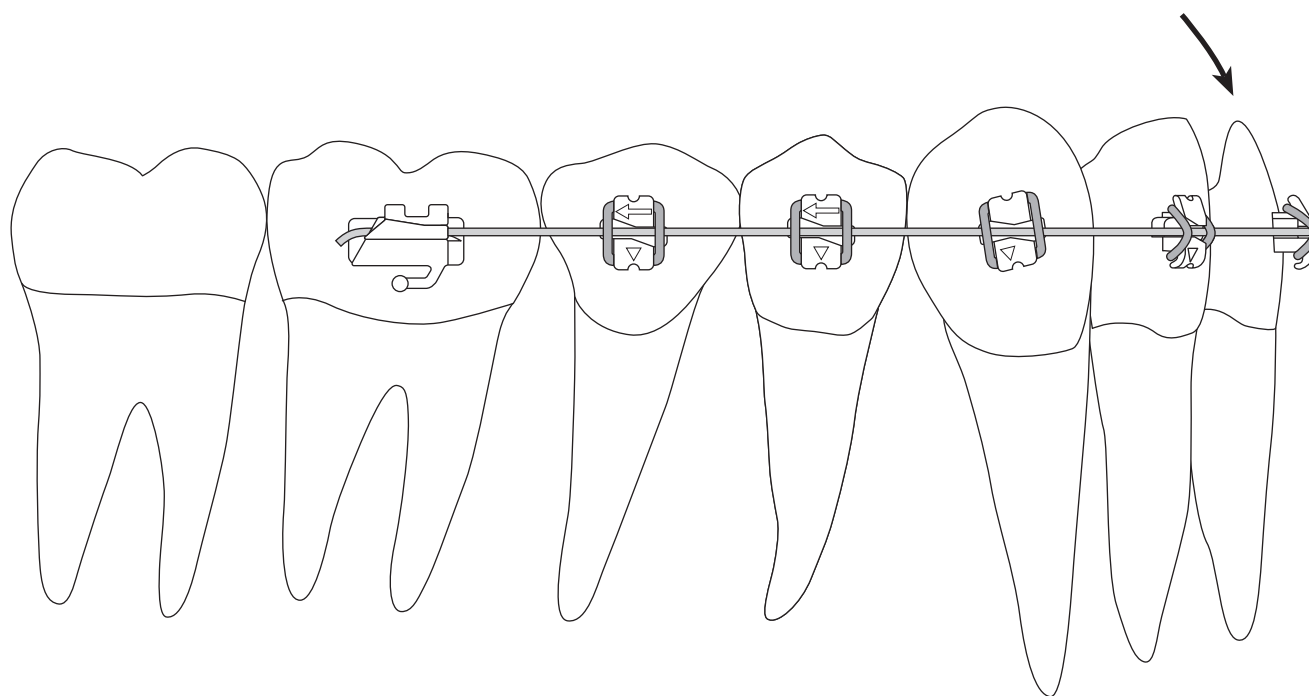


Fig. 3.8 With Tip-Edge, adverse canine angulation does not impede bite opening.

overcome this problem, but at the expense of added complexity.^{2,3} Segmental arches are never required with Tip-Edge and, as will be seen in the clinical cases illustrated, overbite reduction can take place from the outset, irrespective of canine angulation (Fig. 3.8).

The Plus base

The Plus bracket base is revolutionary. It incorporates a 'deep tunnel', which is unique in orthodontics. The idea germinated from the author's aim to dispense with Side-Winders in Stage III.⁴ A simple typodont experiment was set up to assess the feasibility of nickel-titanium, to provide appropriate uprighting forces, in lieu of springs. Special brackets were prepared with labial access 'deep grooves' cut deep to the main archwire slot, into which a nickel-titanium wire could be fitted to power the desired mesio-distal uprighting (Fig. 3.9A). As is normal Tip-Edge practice in the final stage, a rectangular archwire was engaged in the main archwire slots (Fig. 3.9B). The concept was attractive, but a clinical trial revealed that the auxiliary wire would readily escape from its slot beneath the main archwire. Also, the bracket was weakened by the combined depth of both slots. However, TP Orthodontics adopted the principle and, from it, evolved the deep tunnel. Such a concept has only become possible due to the physical properties of the latest generation of nickel-titanium wires.

In common with some current straight-wire brackets, Tip-Edge has always featured a vertical slot lingual to the main archwire slot, which accommodates a range of possible auxiliaries. This is illustrated (Fig. 3.10) with the Rx-1 bracket and is continued in the Plus bracket. The diameter of the vertical auxiliary slot is .020 inches, with a rounded 'funnel shaped' entry to facilitate insertion.

The deep tunnel runs 'east-west' through the base and intersects the vertical slot almost at right angles, describing a plus sign – which is how Plus got its name (Fig. 3.11). Like the vertical slot, the deep tunnel is .020 inches diameter and has a flared exit at either end. The lingual aspect shown in Figure 3.11 is, of course, seen without the meshpad in place. This will provide the fourth wall of the tunnel. It follows that there is neither labial nor lingual access to the tunnel, which therefore requires to be threaded. This is not a difficult procedure and will be described in Chapter 17.

It can readily be appreciated that as the nickel-titanium-auxiliary archwire in the deep tunnel straightens out (Fig. 3.12) it will induce a second order torque force, 'untipping' the root in the appropriate direction. Chapter 14 will explain how this also translates into simultaneous third order torque correction, when used in conjunction with a rigid rectangular main archwire. All bracketed teeth will thus be torqued and tipped concurrently, just as they were with Side-Winders, using the Rx-1 bracket. The action is illustrated diagrammatically (Fig. 3.13).



A



B

Fig. 3.9 (A) A tyodont experiment in 1999 used 'deep grooves' to test the feasibility of nickel–titanium for uprighting. (B) A Stage III rectangular arch was fitted in the main archwire slots in the usual way.

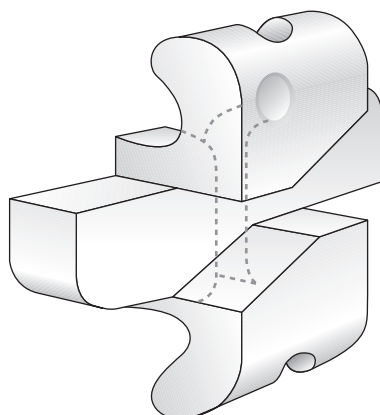


Fig. 3.10 The vertical slot for auxiliaries has a rounded entry (Rx-1) and continues in Plus.



Fig. 3.11 The Plus bracket seen from the lingual aspect without its meshpad. The deep tunnel and vertical slot intersect almost at right angles.

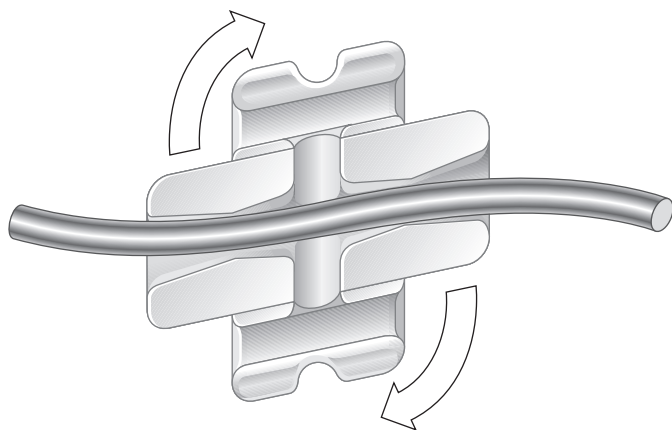


Fig. 3.12 A second order uprighting force is generated by the deflection of the light flexible auxiliary archwire within the deep tunnel.

Inevitably, to facilitate threading, some tolerance exists within the tunnels. The vertical tolerance of a .014 inches auxiliary wire through a deep tunnel equates to approximately 3 degrees of 'tip slop', depending on the width of the bracket. This has been allowed for in the design of the appliance, by means of canting the vertical angulations of the deep tunnels in the direction of over correction (Fig. 3.14). In clinical use, actual over correction will not happen, as the action of the auxiliary is limited by the tip prescription in the bracket face, from the moment the finishing surfaces have closed into contact with the rectangular main archwire. The purpose of the cant is therefore to take out the 'tip slop' and ensure that some activation remains in the auxiliary wire, right up to the prescribed finishing angulation.

This aspect of the Plus appliance is the subject of continuing development in response to clinical experience. Initially,

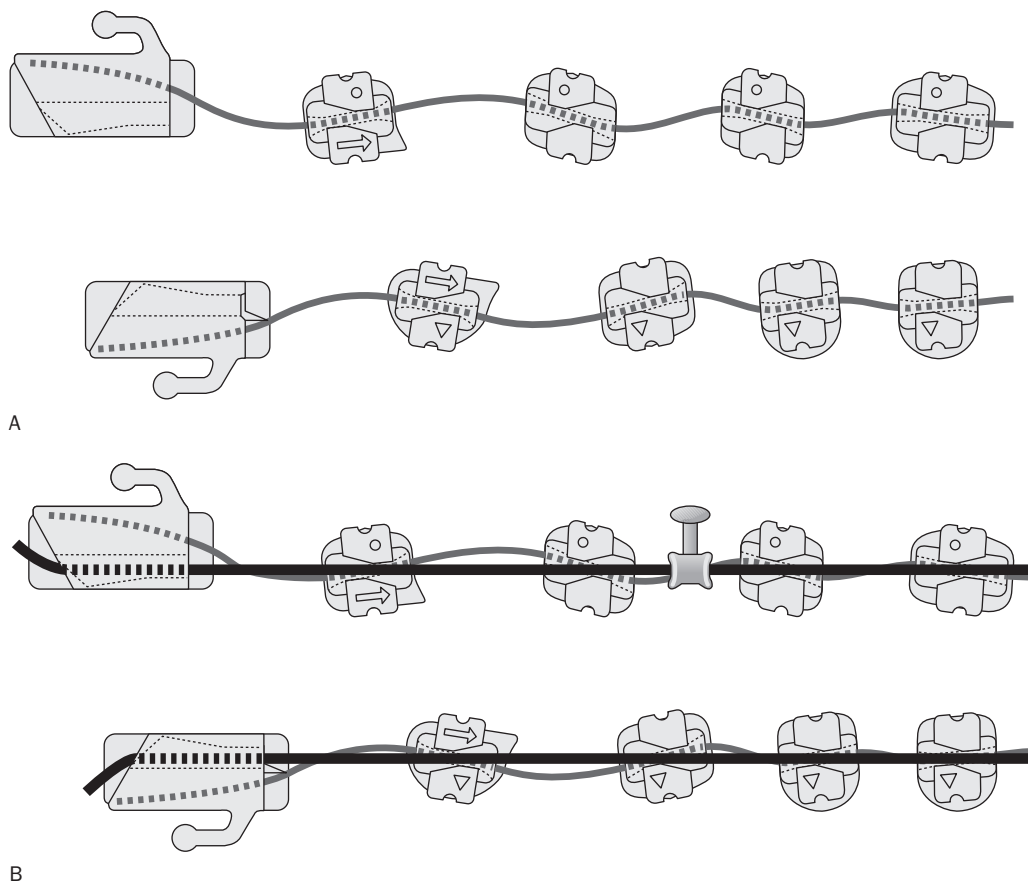
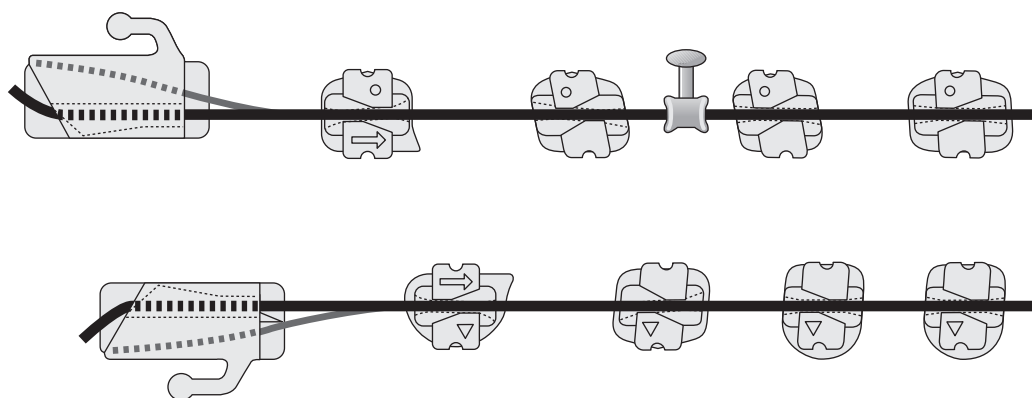


Fig. 3.13 (A) The deep tunnel nickel-titanium auxiliary wire will power the uprighting, instead of Side-Winder springs. (B) The passive rectangular main archwire maintains arch shape and ensures that torque will be delivered by the auxiliary concurrent with tip.



C

Fig. 3.13 Continued (C) Hey presto! Tip (and torque) have been corrected as the finishing surfaces of the main archwire slots have been brought into full contact with the rectangular main archwire.

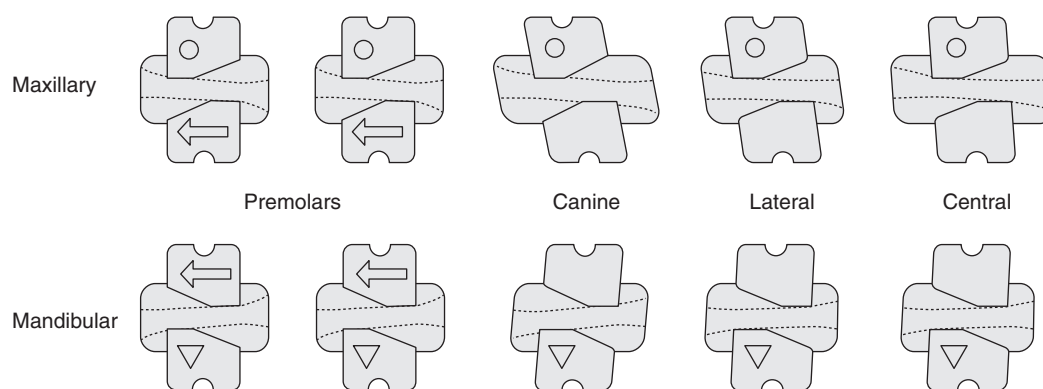


Fig. 3.14 Small vertical angulations of the deep tunnels are designed to take up the small amount of freeplay between the auxiliary wire and the tunnel. The angles of 'over correction' (see text) amount to 5 degrees in all brackets except the lower incisors (3 degrees).

the inclination of the deep tunnels was confined to the incisors. Now it applies to all Plus brackets. In the upper incisors and all premolars, the cant is 5 degrees. In the lower incisors it is 3 degrees, due to the smaller inter-bracket spans. Most recently, and subsequent to the case treatments illustrated in this book, 5 degree cants have been included in the canines also, to ensure full root distalization. The ceramic brackets have the same deep tunnel angles as the metal brackets.

Compatibility of Rx-1 and Plus

Since the geometry of the archwire slot is the same between Rx-1 and Plus brackets, it might be supposed that brackets are compatible and can therefore be 'mixed'. Certainly, the use and action of both systems throughout the first two stages of treat-

ment will be identical. It is only Stage III that differs. Here, obviously, all the brackets must be of Plus design if the deep tunnels are to be utilized. This is because the deep tunnel system requires full auxiliary archwires and any Rx-1 brackets in the set-up will prevent this. The deep tunnels are not intended to be used sectionally and must never be entered in the earlier stages of treatment.

It will also be apparent that the vertical slot in the Plus bracket cannot be used at the same time as the deep tunnel. This is not a problem, however, as Side-Winders will not be required during Stage III.

The first molar tubes

In the interests of combining the advantages of both straight-wire and Begg modes of treatment, Tip-Edge employs double

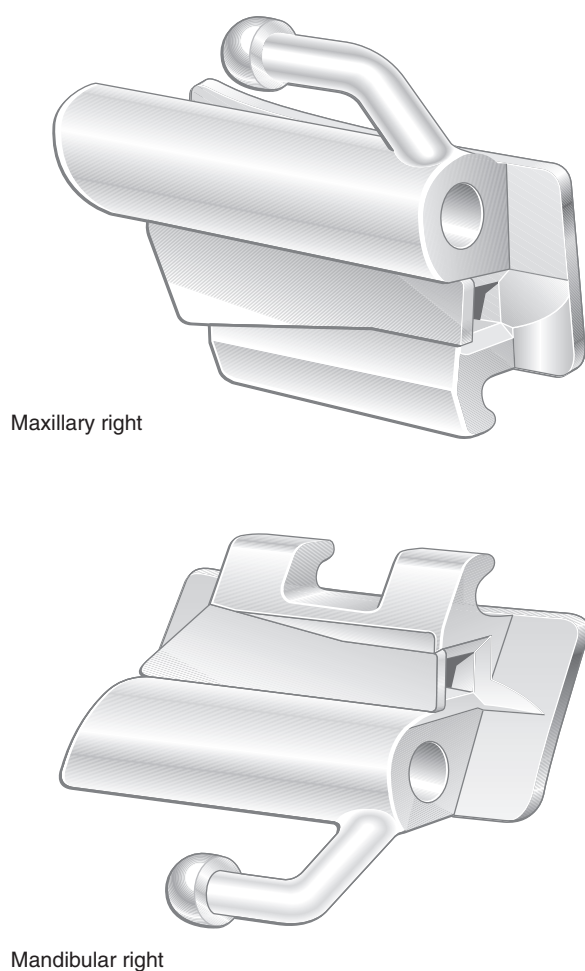


Fig. 3.15 Convertible molar tubes.

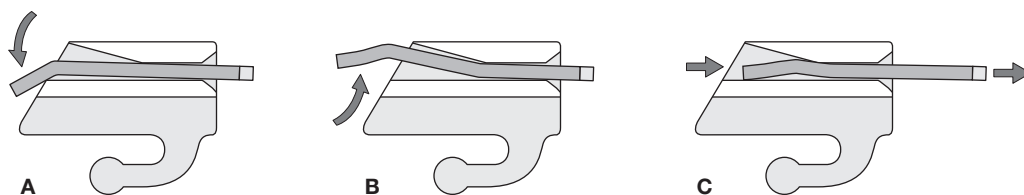


Fig. 3.17 The Easy-Out feature at the distal of the inner lumen of the rectangular tube. (A) Normal cinch back. (B) Straightened out but remains distorted. (C) Progressively smooths out as archwire is withdrawn mesially.

buccal tubes. These comprise a normally sited preadjusted straight-wire rectangular tube of $.022 \times .028$ inch and a gingivally placed round tube of $.036$ inch internal diameter. Two types are available, according to operator choice. One comes with a convertible rectangular buccal tube and tie-wings (Fig. 3.15) so that the tube can become a bracket when the buccal welded insert is peeled away. This facilitates alignment of second molars, if these require to be included, usually at the end of treatment. However now, with improved nickel-titanium wires, many orthodontists prefer to thread the arch-

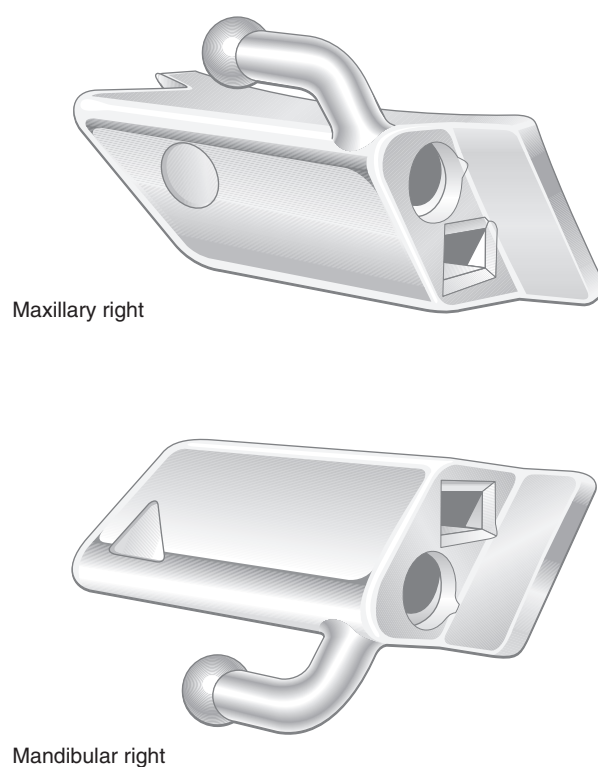


Fig. 3.16 Low profile non-convertible molar tubes.

wire through an intact first molar tube, although this may preclude the use of heavier stainless archwires. More recently, therefore, a non-convertible molar tube has been introduced (Fig. 3.16). Because this carries no tie-wings, it has a lower profile, which helps patient comfort and reduces the chance of occlusal interferences. Either type of tube is appropriate for use with both Rx-1 and Plus systems.

All rectangular tubes are of Easy-Out® (TP Orthodontics Inc., La Porte, Indiana, USA) design, with the posterior inner lumen slightly flared towards the occlusal (Fig. 3.17). This was devised

by Dr Christopher Kesling to facilitate archwire removal when a cinch back has been used, progressively smoothing out the residual 'kink' in the archwire end as the wire is drawn forward. Torque, tip and rotational control are not compromised by this simple modification.

Use of the round tubes, as will be seen later, is confined to bite opening in the initial stages of treatment in deep bite cases. Thereafter, all space closure and root uprighting is carried out using the rectangular tubes. This naturally raises the question as to how necessary the round tubes really are. The answer to this will become apparent in the chapters on Stage I, in that the round tubes do offer significant advantages when deriving molar anchorage and bite opening from 'anchor bends', during which their more gingival position gives better protection from occlu-

sal trauma. In addition, the increased length of the round tubes makes more efficient use of the anchorage bend in terms of bite opening, as well as reducing the friction arising from it.

It will be seen that triple upper molar tubes were featured in many of the cases illustrated in the first edition of *Tip-Edge Orthodontics*. In fact, headgear is hardly ever needed with the Tip-Edge appliance, compared with straight wire. Indeed, none of the cases shown in this book were required to wear headgear, and the presence of headgear tubes in some cases is simply the result of departmental standardization of bands. In this respect, it is worth mentioning that triple upper and double lower molar tubes will allow both straight-wire and Tip-Edge techniques to be practised side by side with a single inventory of prewelded bands.

References

1. **Kesling PC.** Tip-Edge PLUS Guide and the Differential Straight-Arch Technique, 6th edn. TP Orthodontics, Inc.
2. **Burstone CJ.** Deep overbite correction by intrusion. *American Journal of Orthodontics* 1977; 72:1–22.
3. **Ricketts RM.** Development of the utility arch. *Foundation for Orthodontic Research Newsletter* 1974; 5:37–40.
4. **Parkhouse RC.** Current products and practice: Tip-Edge Plus. *Journal of Orthodontics* 2007; 34:59–68.

CHAPTER

4

Auxiliaries

The Side-Winder	29
Power Pin	31
Rotating Spring	32

In its early days, Tip-Edge was used with a host of different auxiliaries. Many of these were Begg derived and designed for orthodontists unfamiliar with rectangular wire. Nowadays, however, the modern orthodontist wants to eliminate elaborate wire bending. With Tip-Edge, the whole problem became greatly simplified with the introduction of preformed rectangular archwires. Apart from the Power Pin™ (a traction hook) and the occasionally useful Rotating Spring, the erstwhile Side-Winder spring answered every need in terms of root uprighting and torquing. For Rx-1 users, it still does. However, now that we have Plus, even the Side-Winder has become redundant during that final torquing and uprighting phase of treatment, when virtually every bracket previously required a spring to achieve its prescribed finish.

A single nickel–titanium archwire running through the deep tunnels is therefore the new auxiliary, which does the job formerly undertaken by all the springs. This does not make the Side-Winder obsolete, however. Even though its use is now occasional, rather than routine, it retains an essential function in the earlier stages of treatment in specific situations. These

include Power-Tipping to prevent unwanted proclination of lower incisors in Stage I (Chapter 10) and ‘braking’ to increase anterior anchorage and correct centrelines, both in Stage II (Chapter 11). In all three of these applications, the Side-Winder is working in the tipping plane only, on round wires rather than rectangular.

Although the deep tunnel wire described in the previous chapter does the work of several auxiliaries, the present chapter confines itself to individual tooth auxiliaries and attachments.

The Side-Winder

This used to be the everyday ‘workhorse’ among Tip-Edge auxiliaries (Fig. 4.1). Primarily, it generates mesio-distal root movement and, with Plus, this is all that will be required of it. For those still using the Rx-1 bracket, the Side-Winder is well proven to produce torque correction as well, when used in conjunction with rectangular archwires. It is made in .014 inch high tensile stainless steel wire.

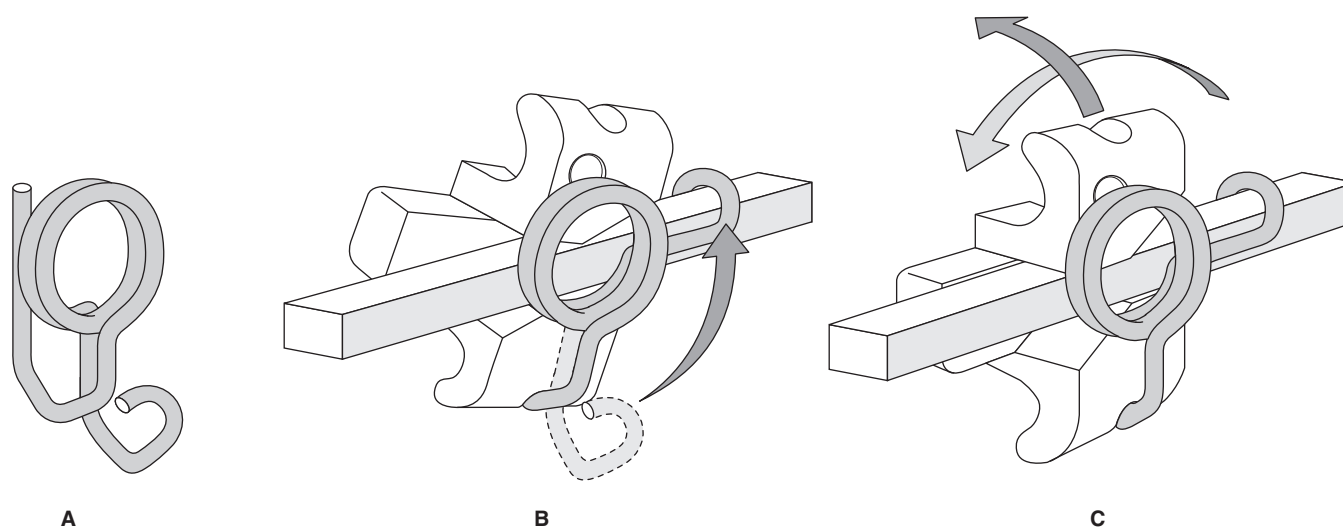


Fig. 4.1 A Side-Winder (A), inserted from the occlusal (upper right central) incisor (B). When the arm is hooked over the rectangular archwire (C), tip correction (light arrow) and torque correction (dark arrow) will result. The elastomeric module has been omitted in the interest of clarity.



Fig. 4.2 The original Side-Winder (right) compared with its 'invisible' successor (left). Note that the Invisible spring is retained by the elastomeric module, and must therefore be fitted before the module is placed. Later versions incorporate a small hook instead of the 'finger', since this could become unhooked lingually.

So called because it carries its coils alongside the archwire, over the bracket face, the Side-Winder was a significant improvement over the original Begg type uprighting spring, which carried its coils gingivally. Because the coils of the Side-Winder are concentric with the point of second order rotation of the bracket, its action is mechanically more efficient, and its hook no longer travels noticeably along the archwire as the tooth uprights. It is also more aesthetic and easier for the patient to keep clean, although it does inevitably add to the labial profile of the bracket.

The Side-Winder has undergone considerable development since it was first introduced, although its mode of action remains the same. Original versions were retained in the vertical slots by bending the long gingival tails 90 degrees, which made them fiddlesome to remove. It was subsequently realized that the spring pressure of the activated arm reciprocally keeps the tail of the spring securely seated up the vertical slot, so that the long tails were deleted. However, by far the most significant improvement came with the so-called 'Invisible Side-Winder' (Fig. 4.2).

This is not strictly invisible, of course, although aesthetics are improved by the fact that the wire of the spring overlays the bracket and archwire so that, unless using ceramic brackets, the show of metal is scarcely increased. Perhaps of greater importance, it has several functional advantages. Firstly, it is retained in position by the elastomeric module, in addition to its own spring pressure. This greatly reduces the risk of detachment and also enables the modules to be changed, if necessary, without removing the springs. Secondly, because the bulbous hook has been greatly reduced, the spring arm has a wider range of activation than was previously possible (Fig. 4.3). Again for Rx-1 users only, the extra power of the spring is an advantage, particularly on incisors, when delivering the final torque prescription, but is unnecessarily strong for simple second order tipping movements. Some reduction of activation on canines and

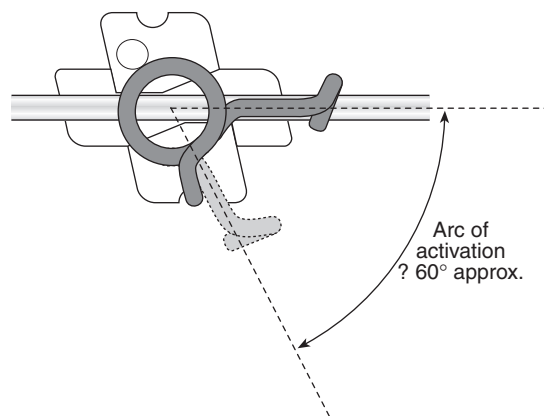
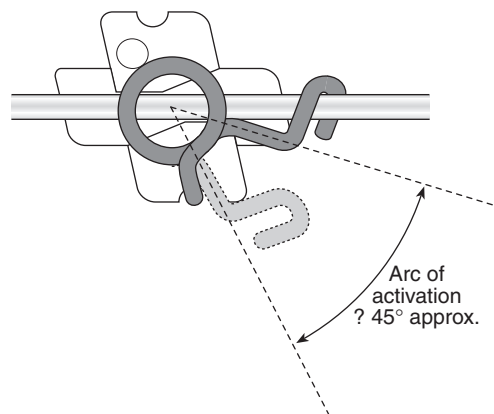


Fig. 4.3 The bulky hook of earlier Side-Winders reduced the arc of activation (above), compared with the Invisible design (below).

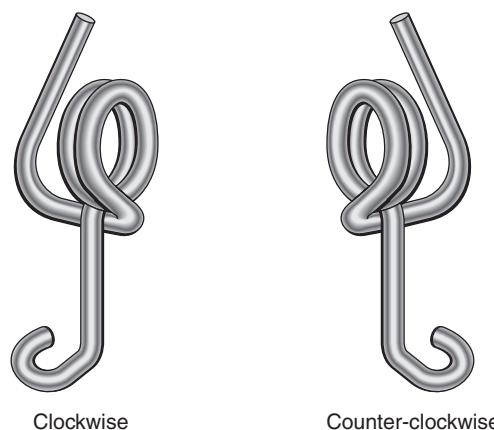


Fig. 4.4 Clockwise and counter-clockwise Side-Winders.

premolars may frequently be indicated, therefore, in order not to strain anchorage during the uprighting phase.

Side-Winders come in clockwise and counter-clockwise formats, the one a mirror image of the other (Fig. 4.4). Selection of the correct spring for each tooth is a simple matter, according

to the direction of second order correction required, as seen from the labial. Hence an upper right canine requiring distal root correction will need a counter-clockwise spring, while uprighting a lower right canine root distally will require a clockwise rotation, and so forth. For the benefit of Rx-1 users, it should be noted here that the selection of Side-Winders is made solely on second order considerations, irrespective of whatever torque may be required. The torque, although generated by the auxiliary, is delivered according to the setting of the rectangular archwire, as will be seen in Chapter 14 on Stage III.

Side-Winder springs should always be inserted from the occlusal and never gingivally. Admittedly the action of the spring will be the same either way, so that on a typodont the direction of insertion might seem irrelevant. But typodonts don't eat. In the mouth, the forces of mastication coming from the occlusal will be deflected harmlessly off the coils of a correctly inserted spring, keeping these in close proximity to the bracket face. However, if the spring is inserted upside-down, from the gingival, the occlusal forces will impact beneath the coils and distort them labially, away from the bracket. This spoils the action of the spring as well as causing discomfort.

The direction of action of each spring can easily be 'read' in the mouth by the clinician, according to the direction of the spring arm. Since each spring is inserted occlusally, the spring arm points in the direction towards which the occlusal tip will rotate.

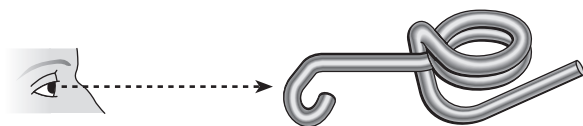


Fig. 4.5 Identifying a Side-Winder: as seen, hook facing, in which direction does the wire turn away from its cut end? If clockwise, it is a clockwise spring and vice-versa.

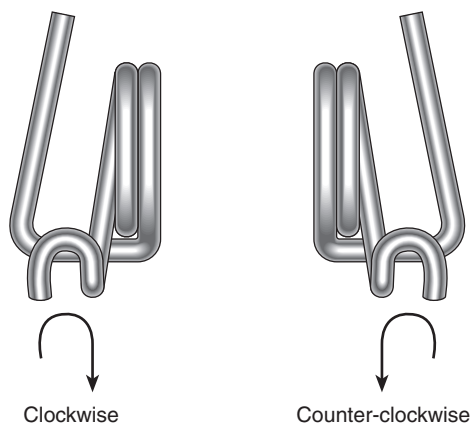


Fig. 4.6 'Reading' a Side-Winder. Since it is inserted occlusally, the spring arm indicates the direction in which the occlusal tip will rotate.

It is also useful for the orthodontist to know how to 'read' Side-Winders out of the mouth, such as when refitting springs that have been removed. Confusion can easily be prevented by this simple method of recognition: holding the spring in a plier, hook facing the operator (Fig. 4.5), in which direction does the hook curve? Starting from its free end, if the hook curves away in a clockwise direction, it is a clockwise spring, and vice-versa (Fig. 4.6).

As with any auxiliary spring, Side-Winders should only be used with stainless steel arches, since nickel-titanium or multi-strand archwires are insufficiently stiff to resist the vertical deflections arising from the active arms of the springs.

Finally, it needs to be said that steel ligature ties and Side-Winders do not mix. The reason is that stainless steel is insufficiently elastic to allow the bracket to rotate relative to the archwire, as is necessary for the correction of tip (and torque). A wire ligature will therefore restrict the action of the spring. Consequently, Side-Winders must only be used in conjunction with elastomeric ligatures, which can readily change shape to accommodate angular changes as they occur.

Power Pin

This is a traction hook that can be fitted in the vertical slot (Fig. 4.7). Made of soft stainless steel, it will normally be inserted from the gingival, and is retained in the slot by bending the occlusally projecting tail 90 degrees (Fig. 4.8). Strictly, this bend should be made in the opposite direction to the elastic pull, since this avoids the possibility of a slackly

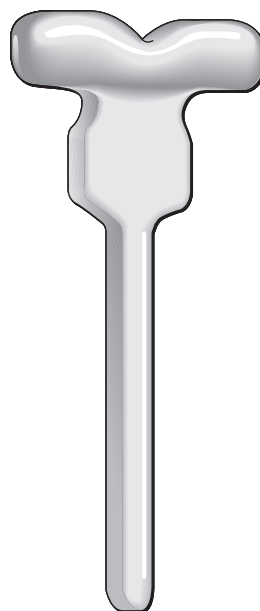


Fig. 4.7 A Power Pin.

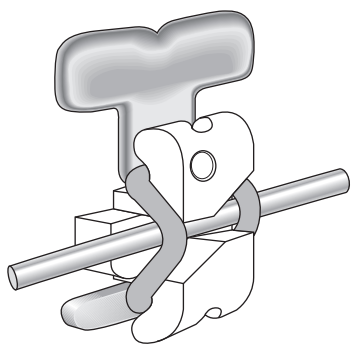


Fig. 4.8 A Power Pin is retained in the vertical slot by bending the tail 90 degrees.

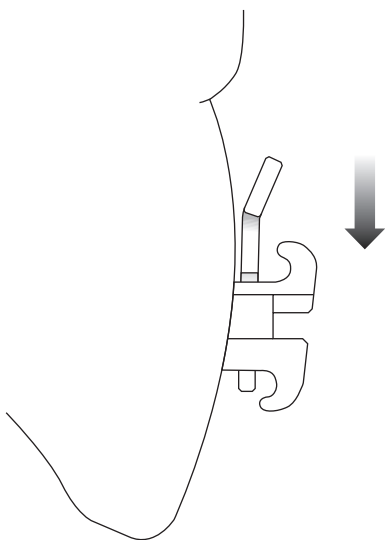


Fig. 4.9 Power Pin in side view. Note that the head is angled from the shaft, and should be fitted to incline away from the gingival margin.

turned pin doing a 'U-turn' and being pulled out of the slot by the elastic.

It can be seen in side view that the head of the Power Pin is angled relative to the shaft (Fig. 4.9). The pin should therefore be inserted with the head inclining away from the tooth or gingival margin, rather than towards it. Once fitted, the Power Pin can be left in place for as long as required; it does not interfere with arch checks. When finished with, its removal is easy, by straightening the tail and cutting it with ligature cutters.

Power Pins are most commonly used as hooks for seating elastics in the final treatment visits. However, they are also useful on the few occasions when an individual tooth requires retraction. Using an elastomeric to a Power Pin, instead of directly to the bracket, reduces the risk of distal rotation, since the bracket is secured by its own elastomeric module, instead of by the end link of elastomeric chain, which will inevitably be stretched open by the traction (Fig. 4.10).

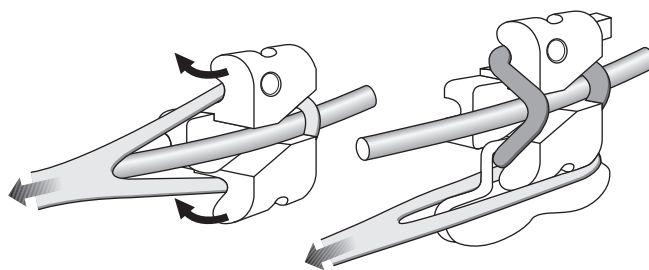


Fig. 4.10 Whenever retracting a single tooth, the risk of distal rotation is avoided by applying a light elastic force to a Power Pin instead of directly to the bracket (see text).

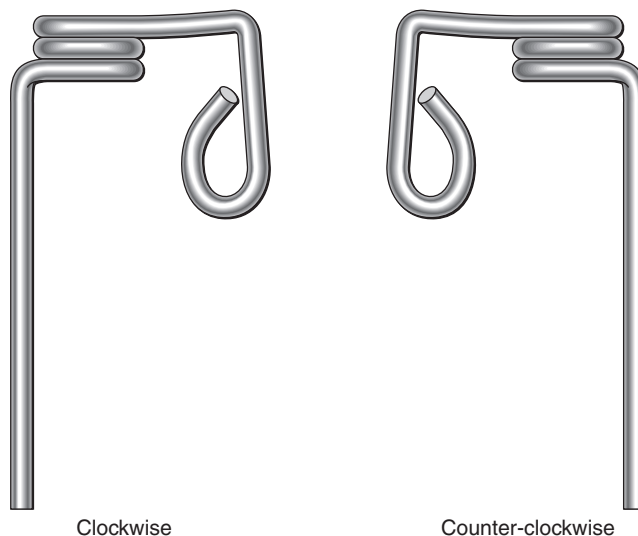


Fig. 4.11 Rotating Springs, clockwise (left) and counter-clockwise (right).

Rotating Spring

The Rotating Spring™ is seldom required for correcting initial rotations. If this sounds a contradiction in terms, it is because rotations of anterior teeth are dealt with by full bracket engagement with light nickel–titanium wires, at the outset of treatment. (Premolar rotations are sometimes corrected with traction elastomers, if bonded later in treatment.) However, the Rotating Spring can prove very useful for recapturing a rotation that has recurred in treatment, particularly if the patient is in a heavy archwire. The commonest instance will be if a ligature or a bracket has detached from a previously rotated tooth. It is then convenient to be able to realign the rotation with the flexibility of an auxiliary spring, rather than having to delay treatment by stepping down to a lighter archwire.

Like the Side-Winder, the Rotating Spring comes in clockwise and counter-clockwise versions (Fig. 4.11), and is made in

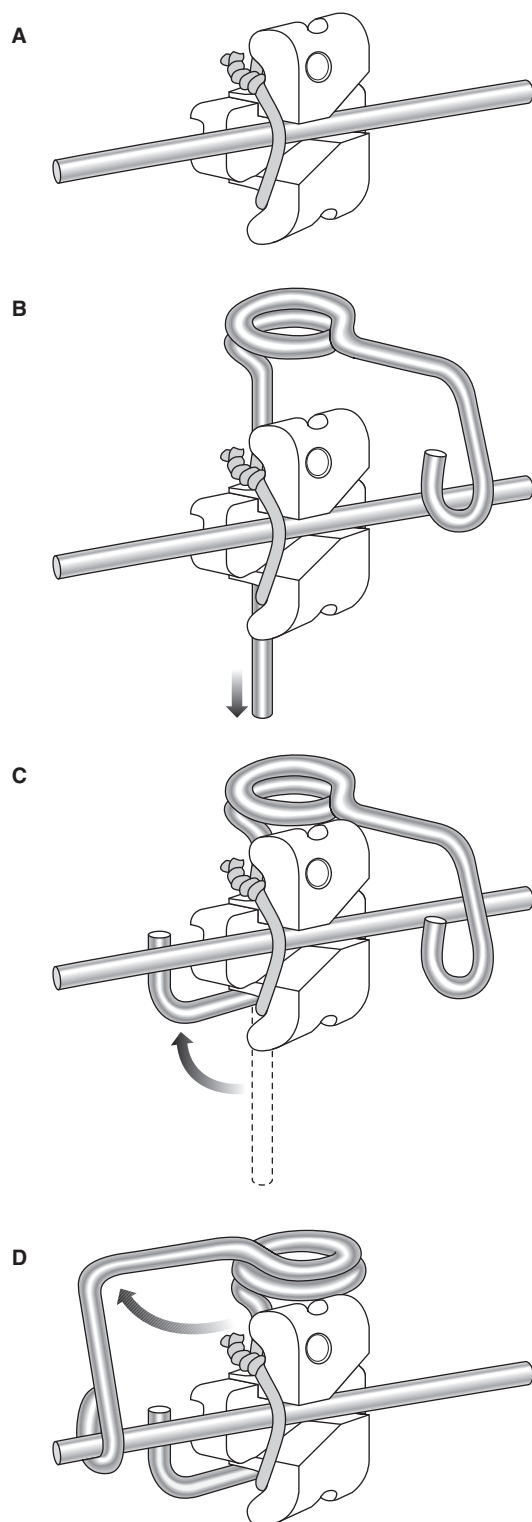


Fig. 4.12 Placement and activation of Rotating Spring. (A) The bracket is wire ligatured, crossing the archwire only at the side in contact. (B) A counter-clockwise spring is inserted from the gingival. (C) Pointing the arm of the spring directly away from the tooth (at 90 degrees to the tooth surface), bend the protruding leg gingivally in two right-angled bends (see text). (D) Hooking the arm around the archwire will now 'wind up' the spring and activate a counter-clockwise rotation (as seen from the occlusal). Squeeze the hook closed to prevent detachment.

.014 inch high tensile stainless steel. Selection is simply a matter of viewing the tooth from the occlusal and determining in which direction derotation is required.

Although many operators use elastic ligatures in the normal way, there is a risk that ligature failure or stretch may allow the spring arm to displace the crown lingually. The former is rare, but the stretch of an elastic ligature should be guarded against by keeping activation of the spring light. The difference between wire or elastic ligatures is that a wire tie will limit the action to a perfect alignment, while an elastic ligature will allow some degree of over-rotation. Either way, the ligature should be placed first, before inserting the spring. It should also go without saying that adjacent space must be available into which the crown can align, since a light auxiliary spring cannot be expected to 'prise open' additional space in the presence of a rigid archwire.

Strictly, a wire tie should only secure the archwire on the side of the bracket which is contacting the archwire (Fig. 4.12A); otherwise, if conventionally tied, the ligature will slacken as the instanding edge of the bracket advances to meet the archwire. Here, care should be taken to ensure that the ligature runs around the backplate, rather than across it (which would impede a complete correction).

To avoid occlusal interference, Rotating Springs should always be inserted gingivally, passed up the vertical slot with a light wire plier (Fig. 4.12B). Holding the spring arm directly to the labial, at 90 degrees to the tooth surface (less if used in conjunction with an elastic ligature) the long leg can be bent along the labial face of the tooth, to the same side as the hook will be engaged, the surplus end then tucking gingivally under the archwire (Fig. 4.12C). This contact of the leg against the crown ensures that when the spring arm is hooked over the archwire, the coils will be wound up to activate the spring. Finally, the hook should be squeezed closed around the archwire, using a Howe plier (Fig. 4.12D). Obviously, Rotating Springs are not intended for tackling severe rotations, where archwire engagement is not possible.

Just as with Side-Winders, Rotating Springs should only be used in conjunction with stainless steel archwires; anything less will be prone to labial deflection due to the action of the spring arm.

CHAPTER 5

Treatment stages

Case 1 A mild Class II division 1 malocclusion with increased overbite and overjet treated with the Plus bracket

38

Treatment stages

Differential tooth movement, as previously defined, involves repositioning of the crowns of the teeth first, followed by root uprighting to the new crown positions. However, there is a prescribed overall sequence of tooth movements, in the correction of any malocclusion with Tip-Edge, that needs to be followed closely. It is basically very simple and goes as follows:

- **Stage I** is all about the anterior segments, which should be aligned, and any incisor spacing closed. They should also be corrected both antero-posteriorly and vertically (eliminating overjets, reverse overjets, increased overbites or anterior open bites). The archwires most commonly used will be .016 inch high tensile stainless steel, the resilience and flexibility of which is ideal for overbite reduction. Nickel–titanium auxiliary ‘under arches’ are frequently employed in the initial treatment visit, to assist in the alignment of instanding or rotated teeth. However, it should be noted that an ‘under arch’ runs beneath the main archwire, in the bracket slot, and never through the deep tunnels. Use of the deep tunnels in Plus is intended for Stage III only.

This first stage will normally be completed in between 6 and 9 months of treatment in Class II cases, considerably less in Class I and Class III cases.

- **Stage II** concerns closure of any residual extraction spaces and seldom exceeds 3 or 4 months, except perhaps in first molar extraction cases. In non-extraction cases, it will obviously be very brief. However, it is important that centrelines should be coincident and correct before all the spaces are closed, since centreline discrepancies will prevent the attainment of a correct Class I occlusion. Also, towards the end of the stage, the first molars will require to be derotated in readiness to receive the rectangular archwires of the third stage.

Normally .020 inch high tensile stainless archwires are preferred during this stage, since they offer easy free sliding through the molar tubes, yet have enough flexibility to correct molar rotation. However, the extra robustness of

.022 inch wires may sometimes be indicated, such as when expanding maxillary crossbites, or when protracting second molars across first molar extraction spaces.

- **Stage III** is the root uprighting phase, during which each tooth is torqued and tipped to its preadjusted values to complete the treatment. Previously, and with the Rx-1 bracket, this was achieved by the action of Side-Winder springs working against rectangular .0215 × .028 inch stainless archwires. The Plus bracket will use a deep tunnel nickel–titanium auxiliary archwire to do the same. The rectangular archwires will be identical in either system. Depending on the severity of the case, this may take up to 9 months to achieve. However, as pointed out previously, what was once a most complicated stage with the Begg appliance, has become largely maintenance free with the new technology of Tip-Edge.

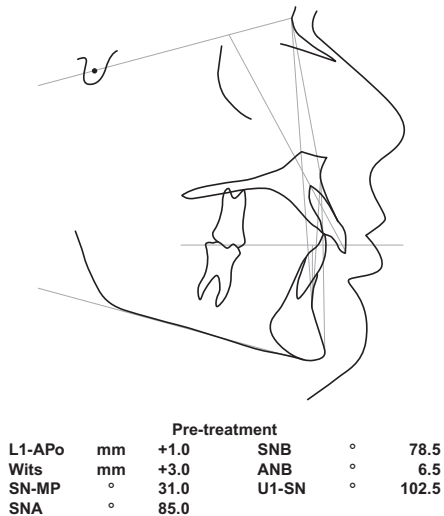
Buccal segment crossbites may be treated as a prior procedure, although this is seldom necessary, except perhaps in cases of severe transverse skeletal discrepancy. While the scope for crossbite correction in Stage I is limited by the light archwires used, it increases during the following stages with greater wire diameter, and particularly in the rectangular wire phase, when expansion can be supplemented by active torque control of the buccal segments.

It might be observed that the three stages outlined above broadly follow the Begg technique, although the method of achieving them is considerably different. Whatever the malocclusion type, the stage goals stay the same and must always be strictly adhered to, although the means to achieve them will obviously vary. For instance, Class II and Class III cases will treat towards the ideal result from opposite directions, with totally different vertical and anchorage considerations. However, the same sequence of stages must always be observed. The overenthusiastic orthodontist who fails to do this by trying to ‘hit everything at once’, improvising short cuts, will usually end up with increased treatment times and imperfect results.

Case 1

A mild Class II division 1 malocclusion with increased overbite and overjet treated with the Plus bracket

Treated by Dr Christopher Kesling



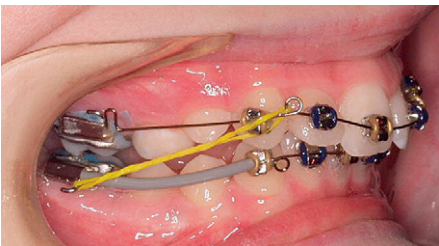
1

At age 10 years 7 months, there is a mild skeletal Class II base but with good lip competence. The lower incisors are 1 mm ahead of the A-Po line.



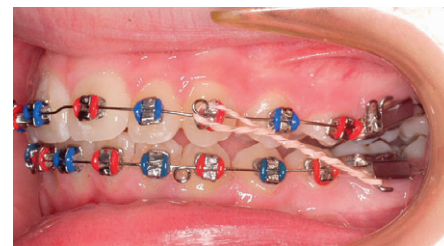
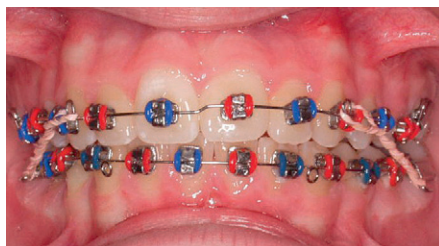
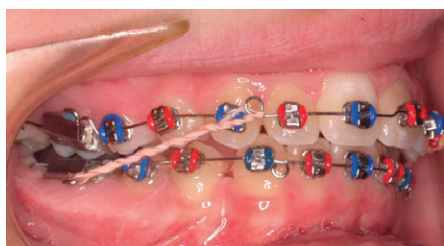
2

There is a moderate increase in overjet and an increased complete overbite. In the late mixed dentition, both upper buccal segments are forward to beyond a half unit Class II, accounting for retained upper second deciduous molars. There is minimal crowding of the upper arch, a well aligned lower arch and a reasonable growth expectancy. A non-extraction approach is indicated.



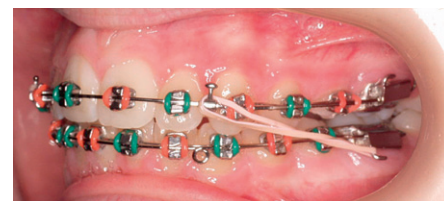
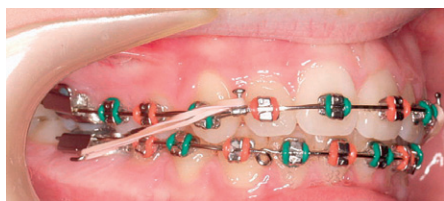
3

Stage I begins with high tensile stainless .016 inch archwires. Because the overbite requires reduction, the premolars are omitted from the appliance. Anchor bends are used to the round molar tubes. Very light (50 grams) Class II intermaxillary elastics will reduce the overjet. Space for the lower premolars is safeguarded by plastic 'Bump-R-Sleeves™', but in the upper, molar stops in the archwire are used instead, to protect the spaces for the unerupted second premolars and to ensure distal movement of the first molars in response to the elastics. These stops can be opened up to produce a little more space if required.



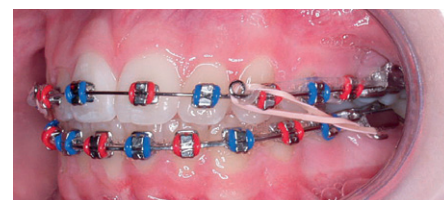
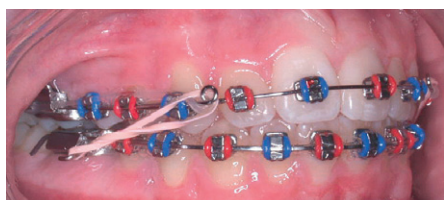
4

5 months into treatment, Stage I is virtually complete. The upper second premolars have erupted and all premolars are now bonded, still using the original .016 inch archwires. A small vertical discrepancy across the upper midline will be corrected with a temporary offset in the upper archwire. At the following visit (not shown) the position of the upper left central incisor bracket is corrected and high tensile stainless Stage II archwires are fitted (for which Dr Kesling prefers .022 inch to .020 inch gauge).



5

Now 9 months into treatment, uprighting begins. The deep tunnels of both arches are threaded with .014 inch nickel-titanium auxiliary archwires. A Stage III rectangular stainless .0215 × .028 inch main archwire, lightly swept and uncompensated, is used in the upper, but the lower continues with a .022 inch round wire, pending a Stage III rectangular archwire.



6

The case is looking good. A lower rectangular archwire is now in place and both deep tunnel auxiliary wires are continued. The upper arch reverts briefly to a swept .022 inch round wire with bilateral E-links to close small buccal segment spaces.



7

After 6 months of uprighting the case is complete. The anchorage requirements were provided entirely by the light intermaxillary Class II elastics.



8

The profile has been enhanced, aided by some favourable mandibular growth.



		Superimposition	
		Pre-treatment	Post treatment
		BLACK	RED
L1-APo	mm	+1.0	+3.0
Wits	mm	+3.0	-3.0
SN-MP	°	31.0	31.0
SNA	°	85.0	84.0
SNB	°	78.5	79.0
ANB	°	6.5	5.0
U1-SN	°	102.5	100.0



9

The lower incisors have advanced to 3 mm ahead of the A-Po line.

Treatment

Treatment time = 1 year 3 months.
 Routine adjustments = 9.
 Main archwires used = 6 (3 upper, 3 lower).
 Retention = Perfector, upper removable retainer. Lower spring aligner.

Bonding and setting up

Bracket placement	43
Premolar brackets	44
Molar bands	45

Since the Tip-Edge appliance is preadjusted, with a torque and tip prescription incorporated in each attachment, it follows that it should be set up just like any other straight-wire appliance. In this, the reader is referred to the work of Dr Lawrence Andrews, who was the originator of the preadjusted appliance and so defined the optimal bonding position for his crown related system.^{1,2} This was designed around the best achievable reproducibility in bracket placement, based on easily visualized objectives, resulting in torque delivery that would prove consistent, irrespective of the size of the crown.

Bracket placement

A mid-crown position is therefore recommended for routine bonding. Each bracket should be aligned with its vertical axis parallel with the long axis of the tooth, and at the mid-point of the crown mesio-distally. The height of the bracket should be at the vertical mid-point of the fully erupted clinical crown (Fig. 6.1). All three dimensions are critical to an accurate end result, as with any preadjusted appliance, so that great care is required at the setting up visit.

Being a considerably smaller bracket than a Siamese twin type has aesthetic advantages, but also makes the accurate placement of the Tip-Edge bracket rather more difficult, particularly on large clinical crowns. For this reason, Tip-Edge brackets are supplied with the option of plastic jigs. Not only do these provide ready 'sight lines' for the correct angulation of each

bracket, but they also make the brackets much easier to handle with conventional bonding tweezers.

Previously, the jigs were produced only in 'L-shaped' form, which prescribes a fixed bonding height for each bracket from the incisal edge or tip, as denoted by the colour coding (Fig. 6.2). While this may have been appropriate for the Begg appliance, it is at variance with the requirements of a preadjusted appliance, in which the measurement of the mid-crown point to the incisal edge will vary according to the overall size of the crown. The L-shaped jigs are still available, but the more recently introduced Universal jigs are a better option (Fig. 6.3). These can easily be aligned up the long axis of the tooth, while the mid-crown height can be gauged by eye (Fig. 6.4). On a normally shaped incisor, correct angulation up the long axis will result in the incisal tie wing being parallel to the incisal edge of the crown.

The rationale behind a mid-crown bonding position is that the middle point of the crown is generally the point of greatest convexity on the curvature of the labial surface. It therefore follows that placing a pretorqued bracket further gingivally will decrease the torque prescription, while placing it too incisally will increase the torque. Reliance on L-shaped jigs frequently results in the latter. In addition, clinical experience shows that a true mid-crown position, as opposed to a more incisal bonding position, significantly reduces occlusal interference and hence

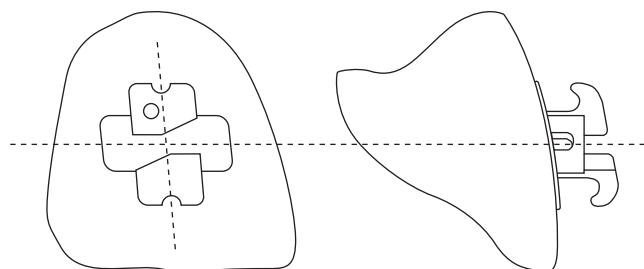


Fig. 6.1 Correct mid-crown bracket alignment (after Dr L. F. Andrews).

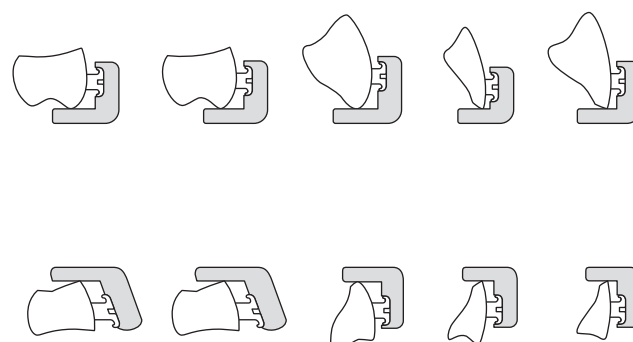


Fig. 6.2 L-shaped positioning jigs (supplied as an option) prescribe a fixed bonding height from the incisal edge, which may be inappropriate to a preadjusted appliance.

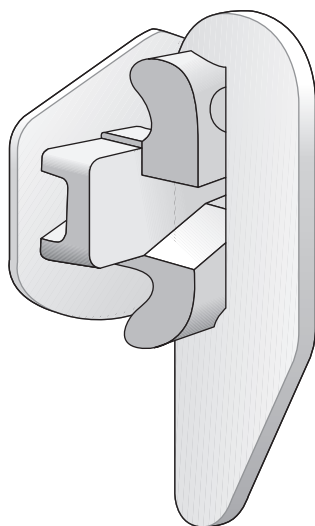


Fig. 6.3 Universal bonding jigs are the recommended option.

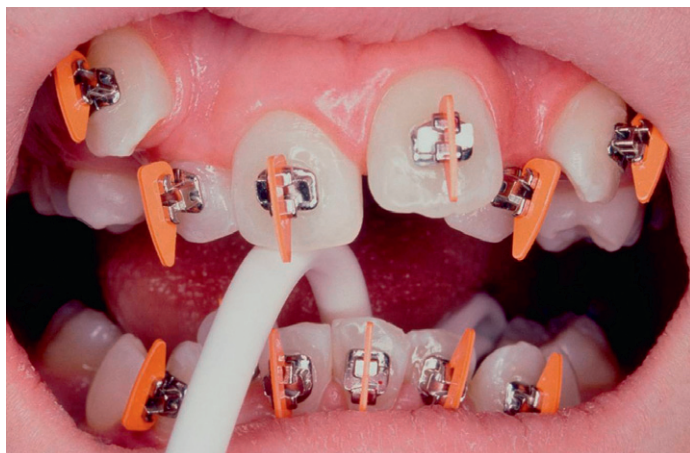


Fig. 6.4 Direct bonding at mid-crown.

cuts down on the number of accidental debonds, particularly on lower canines and premolars.

Overall, there are three major reasons why an incisal bonding position is contraindicated:

1. The prescribed torque value in the bracket base is effectively altered, as described above.
2. For any given overjet reduction, the amount of retroclination produced during the initial tipping stage will be increased by siting the brackets towards the incisal tip. In turn, this will require an increase in the amount of root uprighting during Stage III.
3. When the auxiliary spring or deep tunnel wire uprights the root, in both tip and torque planes, during the third stage, it is placed at greater mechanical disadvantage if the distance between the point of rotation and the root apex is increased. This results in some loss of efficiency.

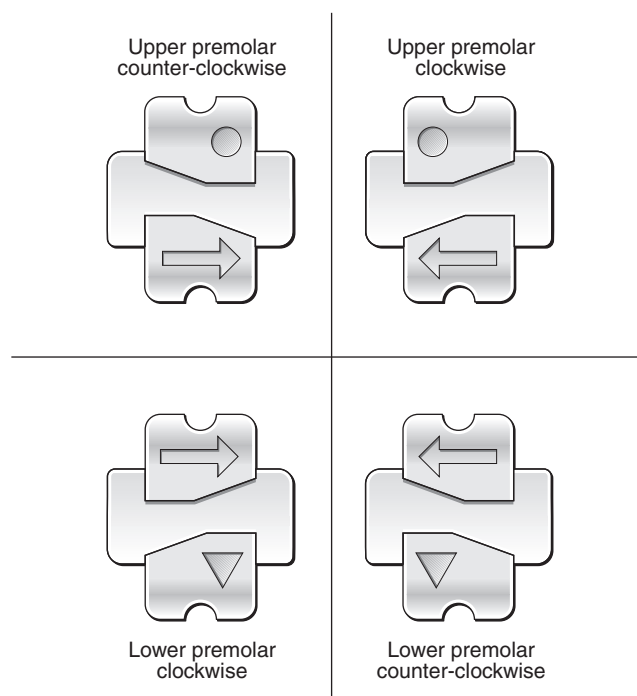


Fig. 6.5 Premolar brackets are selected according to the direction of mesio-distal tipping.

Premolar brackets

Whereas anterior Tip-Edge brackets are designed to allow distal crown tipping during translation in the first stage of treatment, premolars may require to tip either mesially or distally, according to the extraction pattern. For instance, in a first molar extraction case, a second premolar will require to tip distally. However, if first premolars have been extracted, the same second premolar will need to tip mesially into the extraction space. Such situations are readily predictable, but might call for an unwieldy inventory of premolar brackets, in order to satisfy every possibility. The manufacturers have therefore simplified bracket selection by using identical torque and tip values in upper first and second premolars, and similarly in the lower arch. In selecting the brackets, therefore, it becomes irrelevant as to whether it is a first or second premolar, left or right sided. All that the orthodontist needs to consider is whether the premolar is an upper or lower, and whether it is required to tip clockwise or counter-clockwise.

The notation on the bracket faces provides a simple check. Upper premolar brackets are identified by circular markings on the tie wings, lowers by triangular markings. These are offset towards the direction of tip. On the occlusal tie wings, an arrow is an additional indicator of the direction of rotation (Fig. 6.5). With the coming of the Plus bracket, an even better method of notation was devised by incorporating a 'pointer' into the base of the bracket itself (Fig. 6.6). This feature immediately identi-

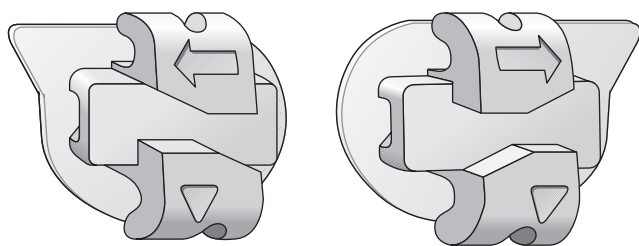


Fig 6.6 Additional identification of directional tip is provided by the 'finger pointer' on the bracket base (Plus and Rx-1).

fies a clockwise from a counter-clockwise tipper and now appears on the Rx-1 bracket bases also.

The various possible extraction patterns are illustrated (Fig. 6.7) from which it will be seen that the arrows invariably point towards the extraction site or, in a non-extraction case, towards the distal. In fact, as a rule of thumb, all the arrows point distally, with the exception of second premolars in first premolar extraction cases, as already mentioned.

In deep bite cases, as will be seen in the next chapter, premolar bonding is deferred until the end of Stage I.

Molar bands

With Tip-Edge, the use of bonded first molar tubes is contraindicated. This is because the withdrawal of the rectangular archwires at the end of Stage III is likely to cause bond failure. The extra security of molar bands is therefore recommended.

The rectangular buccal tubes should be aligned to the brackets, at mid-crown height, just as with a straight-wire appliance. The round tube will therefore sit towards the gingival margin. In the mandibular arch, the tubes should be parallel to the occlusal cusps; in the maxillary arch, however, seating the band fractionally higher toward the distal may be helpful in obtaining final seating of the disto-buccal cusp.

Second molars are not banded at the outset, except of course in first molar extraction cases, when they should be banded as just described for the first molars. Second molars are unnecessary to reinforce bite opening, contrary to straight-wire practice, and their inclusion in the early stages, particularly in extraction cases, merely adds friction. However, final alignment of second molars during the finishing phase is frequently necessary. If so,

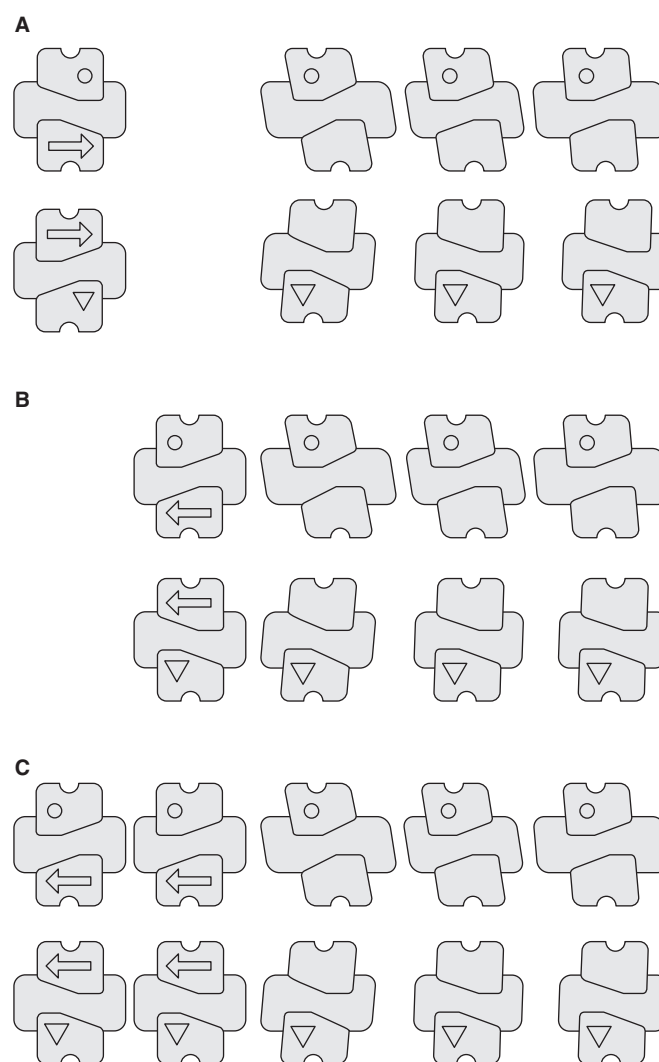


Fig. 6.7 Correct selection of premolar brackets for different extraction configurations: A = first premolar extractions, B = second premolar extractions, C = first molar extractions or non-extraction.

generally towards the conclusion of Stage III, conventional .022 × .028 inch rectangular tubes are used, either prewelded or bonded. Second molar tubes are available, although not specifically for Tip-Edge, with minus 14 degrees of torque and 10 degrees of distal offset (maxillary) and minus 10 degrees of torque and zero offset (mandibular).

References

1. **Andrews LF.** Straight-Wire – the concept and the appliance. Los Angeles: Wells Co; 1989.
2. **Andrews LF.** The straight-wire appliance – explained and compared. *Journal of Clinical Orthodontics* 1974; 10:174–195.

Stage I

	Objectives	49
	Anchorage mode	49
	The Class II case	49
	Anchorage control	51
Case 2	A Class II division 1 malocclusion with severe anterior crowding treated with the Plus bracket	53
Case 3	A severe Class II division 1 malocclusion with a marked unilateral overjet treated with the Plus bracket	57

Objectives

1. Alignment of upper and lower anterior segments.
2. Closure of anterior spaces.
3. Correction of increased overjet or reverse overjet.
4. Correction of increased overbite or anterior open bite.
5. Work toward buccal segment crossbite correction.

The aims of the first stage are simply directed at correcting the anterior teeth, with the exception of centrelines, which generally do not require consideration until Stage II. However, the method of carrying out Stage I may vary considerably, depending on the type of malocclusion, the skeletal pattern, age of patient and the degree of available space.

The technique used in achieving these objectives is exactly the same with the new Plus bracket as it was with the former Rx-1 bracket; the only differences come in Stage III.

Anchorage mode

Since the Tip-Edge appliance has the capability of combining the treatment advantages of both Begg and straight-wire concepts, it has the flexibility to proceed in either mode, while exploiting the advantages of differential tooth movement. Anchorage may therefore be derived from a number of possible sources.

The principles of variable anchorage with Class II traction were first demonstrated by Dr Begg, and an evolved version of this works well with Tip-Edge in the treatment of most Class II malocclusions, particularly those with increased overbite, and is dramatically effective in difficult deep bite cases. The reason for using Class II intermaxillary elastics in preference to headgear, wherever suitable, is ease of wear for the patient, leading to better compliance. Also, it is appropriate to say here that the side effects commonly attributed to Class II intermaxillary traction, such as clockwise rotation of the occlusal plane, opening of the mandibular angle and elongation of the upper incisors, while no doubt true with conventional fixed appliances, can be

avoided with the use of such light forces as Tip-Edge allows, in correctly selected cases.

Class I and Class III cases, without deep overbites, will frequently be treated by purely horizontal mechanics. Moreover, the high mandibular angle Class II facial type may require particular caution, avoiding any potentially extrusive mechanics, such as vigorous anchor bends, which might risk the deleterious side effects mentioned above. In extreme situations, the intrusive forces which can be derived from headgear can be used to advantage with Tip-Edge which, being a light anchorage technique, is highly responsive. However, whichever way any case is approached, the objectives of the first stage always stay the same.

Because the maximum difficulty malocclusion, with large overjet, increased overbite and crowding, uses the method least familiar to most orthodontists, this will be described here. It is very effective in the treatment of the majority of Class II division 1 and division 2 cases.

The Class II case

A clinical case at the outset of treatment (Fig. 7.1) illustrates a Class II malocclusion with upper and lower anterior crowding and an increased overbite. Four first premolars have been extracted to gain the necessary space for overjet reduction and alignment. The mechanical principles in Stage I are therefore designed to align both anterior segments, concurrent with correction of overjet and overbite. To achieve this, .016 inch high tensile stainless main archwires are used, to control the molars and overall arch width, and also to begin overbite reduction. Simultaneously, upper and lower sectional nickel-titanium 'underarches' provide the additional local flexibility for the alignment of the instanding incisors, in the initial treatment visits. It should be stressed at this point that an underarch runs through the main archwire slot and never, in the Plus bracket, through the deep tunnels. In instanding teeth (such as, in this case, the upper left central and lateral incisors) it will be the only archwire engaged. Elsewhere, in the aligned units, it shares the slot with the main archwire, running beneath it.

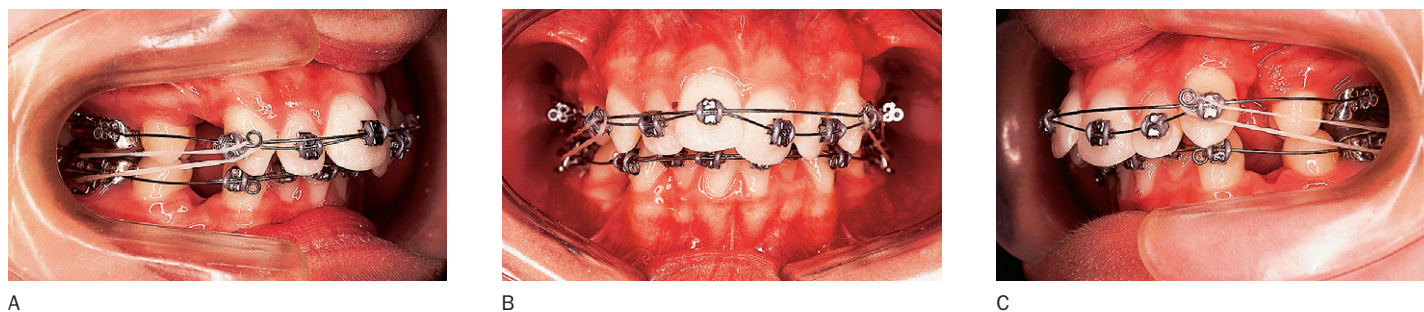


Fig. 7.1 Start of Stage I. In this severely misaligned upper arch, engagement to the main archwire is only possible with three anterior teeth, and the rotated upper right canine has a wire ligature safety tie through the vertical slot to prevent accidental disengagement. Beneath the .016 inch main archwires, the nickel-titanium underarches are .014 inch (upper) and .012 inch (lower).

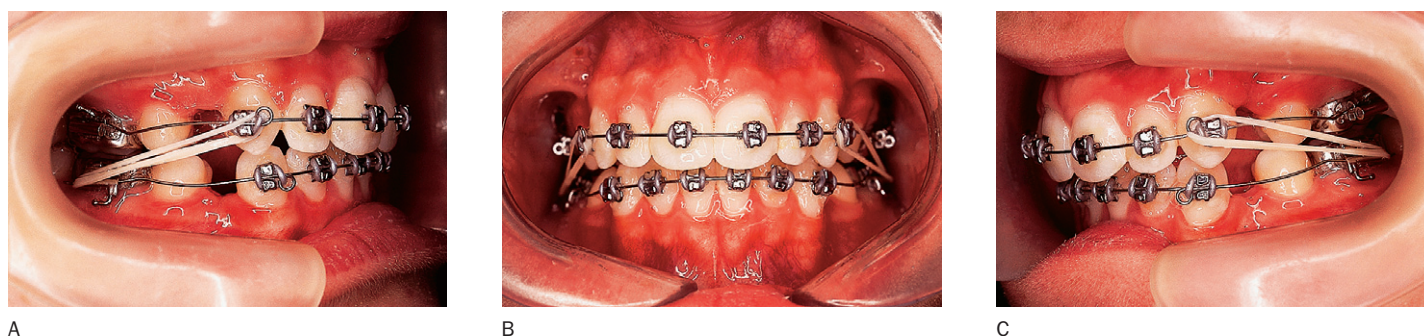


Fig. 7.2 Three months later, the underarches have been discarded. Because the labial segments are now in alignment, the canine brackets are ligated to the cuspid circles to prevent anterior spacing and archwire swing. Overjet and overbite reduction is ongoing.

Vertical control of the incisor segments is by means of anchorage or 'tip-back' bends, placed 2 mm mesial to the upper and lower first molar round tubes. These will induce intrusion to both upper and lower labial segments as well as mesial root movement to the molars, so preventing loss of anchorage. It will be noted that the premolars are omitted from the appliance during overbite reduction. This is because the intrusive effect of the anchor bends mesial to the molars needs to be passed directly to the anterior teeth, without any vertical interference from the premolars in mid-segment.

Overjet reduction proceeds concurrently, by means of light (50 grams) Class II elastics, worn full-time, from the 'cuspid circle' hooks mesial to both upper canines, to the archwire ends distal to the lower first molar tubes.

It is seldom appreciated just how little force is required to move teeth, if the brackets allow them to tip. This answers a frequently raised question: why are the canines not retracted first, in extraction cases? There is seldom need for this, since the canines are free to tip distally into the space available, and can slide along the archwire, without bracket binding, to permit decrowding of the incisors. This they do readily, in response to the instanding lateral incisors seeking space for themselves in the line of the arch. In the upper arch, control of the overjet is

taken care of by the intermaxillary elastics, but even in the lower anterior segment, little transient proclination will result from rapid initial alignment. This is in marked contrast to conventional bracket systems, in which simultaneous bracket engagement on all crowded incisors will provoke proclination of the anterior segment, which may prove difficult to retrieve. The culprit is the canine which, if bodily controlled by an edge-wise type bracket, effectively acts as an 'anchorage unit'.

After one or sometimes two treatment visits, the incisors will be aligned and the overjet and overbite partially reduced (Fig. 7.2). The nickel-titanium underarches have served their purpose and can be removed. It may be necessary to roll the cuspid circles distally along the archwire to regain their position at the mesial of the canine brackets, which will have migrated distally to accommodate the instanding incisors. This is easily accomplished using the round beak of a loop-forming plier within the circle, as shown in Figure 7.3. Similarly the upper anchor bends will require periodic repositioning mesially along the archwire, to prevent them disappearing into the molar tubes as the archwire moves distally, during overjet reduction.

Once the anterior segments are aligned, the canine brackets in each arch should be ligated around the cuspid circles on the archwire with an elastomeric ligature, in the manner shown in

the next chapter, since further distal canine migration will not be required. There are two reasons why these ligatures need to be maintained during the remainder of Stage I:

1. They keep the six anterior units together as a block, not allowing space to enter the segment, as easily happens when teeth are allowed to tip.
2. They prevent the archwire from slipping from side to side.

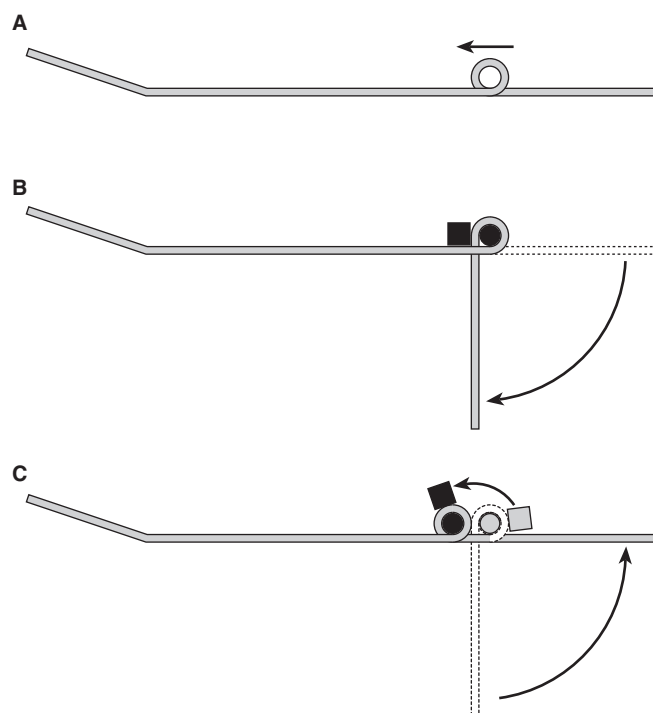


Fig. 7.3 Repositioning cuspid circle. To 'roll' circle distally (A), will require counter-clockwise rotation. First, unravel the anterior section the desired amount using a light wire plier (B), before winding up the posterior section to restore the horizontal (C). (Doing it in this sequence involves only a single section of wire between the plier beaks throughout.)

Stage I is complete when the overbite and overjet have been reduced, with enamel-to-enamel contact achieved above the lower brackets (Fig. 7.4). This is the time to bond and align the premolars prior to Stage II.

It must again be emphasized that the deep tunnels in the Plus bracket are intended for Stage III use only. They are not intended for aligning displaced units in Stage I. Why is this? It is because the deep tunnels are designed for uprighting. They will therefore resist tipping if threaded with an auxiliary wire. Attempting to use them in Stage I, apart from the difficulty in threading crooked tunnels, will result in unwanted bodily control, inducing heavy anchorage and likely proclination of crowded incisors.

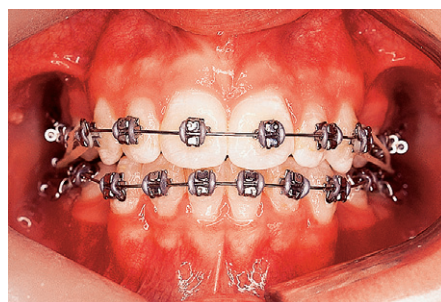
Anchorage control

The above method illustrates the principle of variable anchorage, whereby the increased overjet and overbite are harmoniously resolved by a careful balance of forces (Fig. 7.5). Basically the six upper anterior teeth, being free to tip, comprise a light anchorage segment. By means of the Class II elastics, these are pitted against two lower first molars, which are maintained under bodily control by the mesial apical influence of the anchorage bends in the archwire. These bends reciprocally encourage depression of the lower anteriors. The lower molars therefore 'dig their heels in' to resist the light mesial pull of the elastics, utilizing Dr Tweed's 'tent peg' principle for anchorage control, as described in Chapter 2. Similarly, the upper anchorage bends prevent mesial migration of the upper molars, by imparting mesial apical resistance. Care must be taken, however, to ensure that the elastic force is kept to a minimum, not exceeding 50 grams (2 ounces). Otherwise, the increased vertical component from too heavy an elastic can overwhelm the intrusive effect of the light maxillary archwire at the front, and so elongate the upper anterior segment, as well as encouraging over-eruption of the lower first molars.

Using this pattern of anchorage control, the assistance of second molars is unnecessary, either for overbite or overjet



A



B



C

Fig. 7.4 Six months into treatment, the case shown in 7.1 and 7.2 has completed Stage I. The premolars are bonded in readiness for Stage II at the next visit.

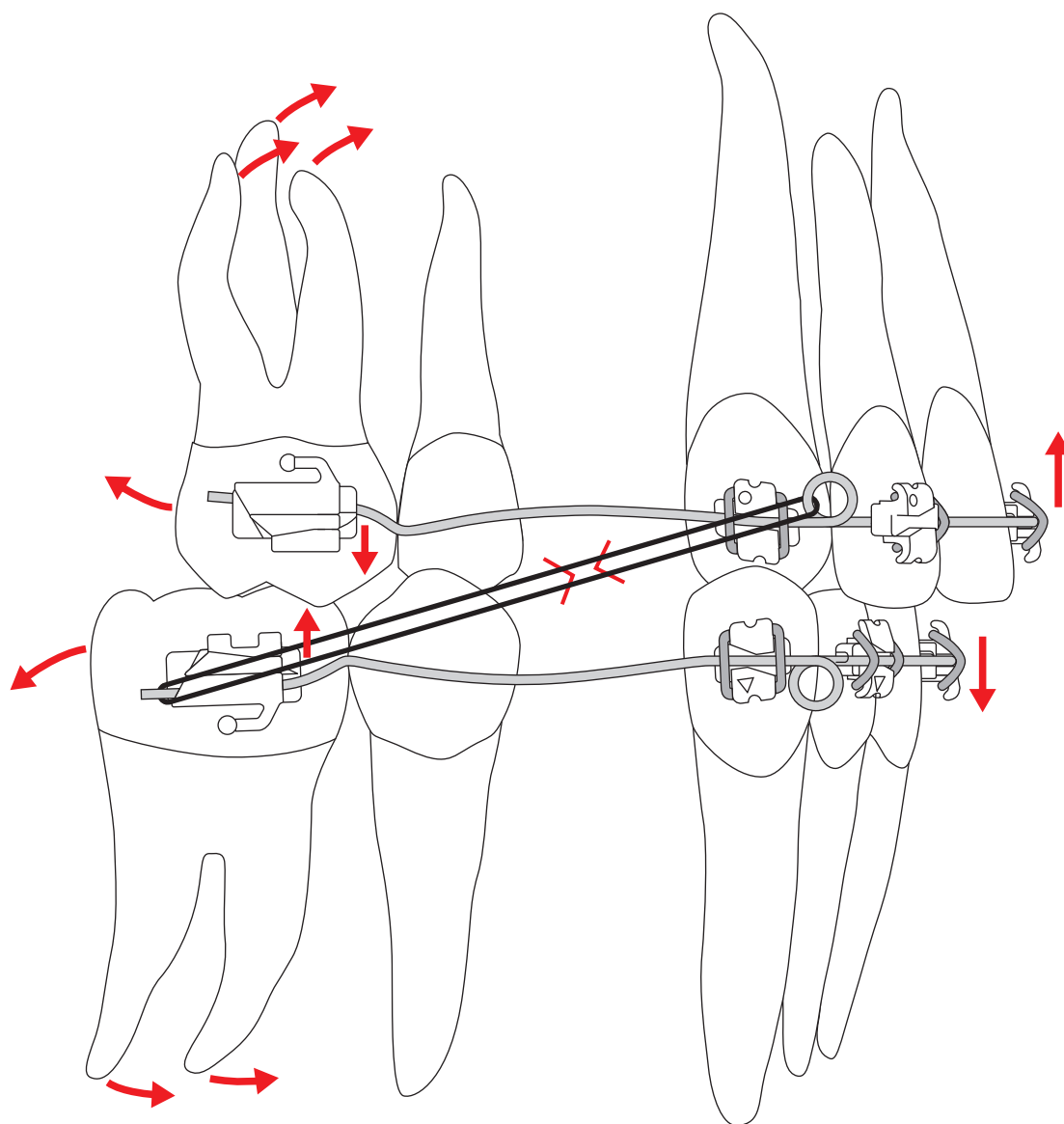


Fig. 7.5 Balance and distribution of forces during Stage I, when using light Class II intermaxillary elastics and first molar anchorage bends.

reduction. In fact, to include second molars in the appliance during the first stage is obstructive, as they create added friction during this and the space-closing stage.

However, consideration must be given to overall vertical consequences, and not simply to what we see happening in the mouth. Vertical forces imparted to the first molars by the anchorage bends need to be recognized. Clinical experience suggests that lower first molars extrude more readily than the uppers, no doubt due to the tip-back archwire bends and Class II elastics acting in combination, but also because of their more tapered root anatomy, compared with the triple divergent roots of maxillary molars. Obviously, therefore, it behoves the orthodontist to keep forces very light, which Tip-Edge readily permits (as in Case 7). This requires a radical departure from conven-

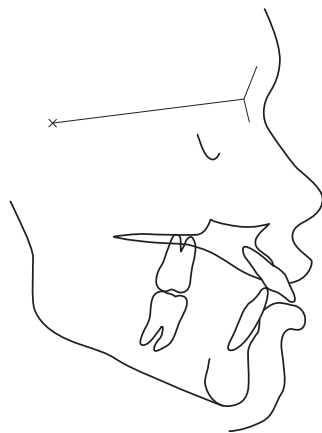
tional force thinking, familiar to the straight-wire and edgewise orthodontist.

Whether or not the vertical reciprocals on first molars express as actual extrusion (even with optimal light forces) will depend on the skeletal pattern and the attendant forces of occlusion generated by the 'muscular envelope'. In this, it is well recognized that the 'low mandibular angle' individual, with reduced lower face height, has stronger musculature compared with the high angle facial type. It is the latter 'long face syndrome' case that is most vulnerable to extrusive forces to the posterior teeth, and for whom it is so important to go easy on the anchorage bends.

Examples of how to handle Stage I in various other mal-occlusion types are described in the relevant clinical cases.

Case 2

A Class II division 1 malocclusion with severe anterior crowding treated with the Plus bracket



Pre-treatment				
SKELETAL		TEETH		
SNA	°	87.5	Overjet	mm 9.5
SNB	°	83.5	Overbite	mm 3.5
ANB	°	3.5	UI/MxP	° 128.0
SN/MxP	°	2.5	LI/MnP	° 97.0
MxP/MnP	°	29.5	LI-APo	mm 4.5
LAFH/TA FH	%	58.5		

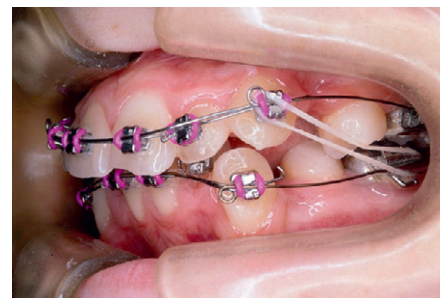
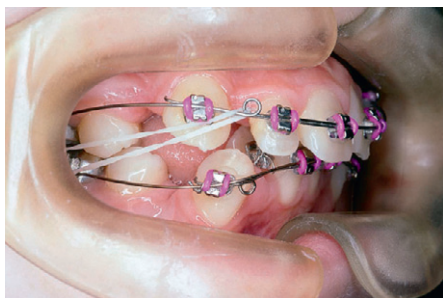
1

At 14 years 7 months, an overjet of 9 mm on a class 1 base with bimaxillary proclination. Apart from the projection of the upper lip by the proclination of the upper incisors, however, the profile is considered to be good.



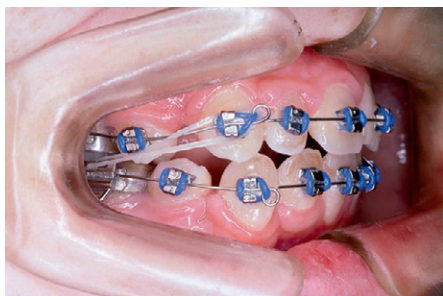
2

All four canines are grossly crowded and there is a supernumerary upper right lateral incisor. Both lower lateral incisors show bodily displacement lingually and the upper left central incisor has a minor crown fracture. Four first premolar extractions are obviously indicated, in addition to the distal of the two upper right lateral incisors. It is decided to accept the proclination of the lower central incisors in order to maintain a strong profile with an acceptable degree of facial convexity.



3

Stage I uses high tensile .016 inch stainless archwires. The premolars are omitted as there is an increased overbite to reduce. Moderate anchor bends are used with round molar tubes, in conjunction with light (50 grams) Class II elastics, worn full time. .014 inch nickel-titanium underarches align the instanding lateral incisors as the overbite and overjet reduce, during which the supernumerary space will be gathered in.



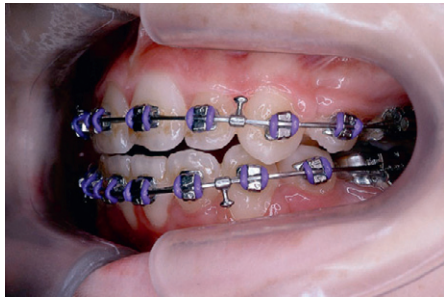
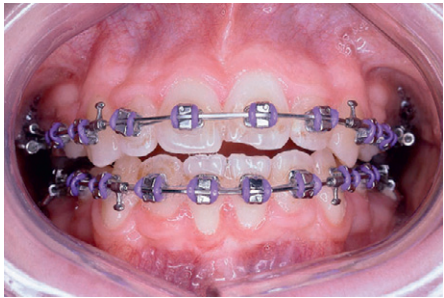
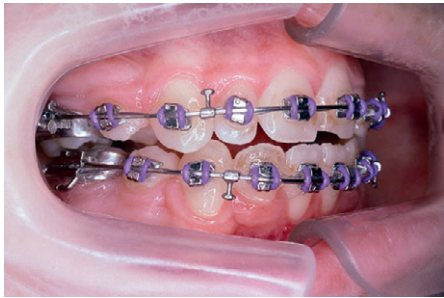
4

After 3 months, the anterior segments are aligned and the overjet and overbite reduced. The cuspid circles are ligated around the canine brackets to prevent ingress of space. The premolars are bonded, to be aligned to the rectangular molar tubes (a short section of .014 inch nickel-titanium underarch is needed to align the lower left premolar, which is lingually displaced and over-erupted). The anchorage bends in the archwire are replaced with bite sweeps to maintain overbite reduction.



5

One month later, Stage II .020 inch high tensile stainless archwires are placed with shallow bite sweeps. In the lower left quadrant, all space has closed. A molar offset and toe-in are placed in the archwire and the arch end lightly cinched. In the remaining three quadrants, E-6 horizontal elastomers will close the small remaining spaces by retraction.



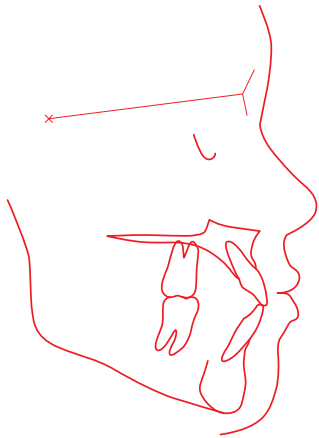
6

Now 7 months into treatment, Stage III begins. The deep tunnels are threaded with .014 inch thermally activated nickel–titanium archwires (Sentalloy upper, Copper Ni-Ti lower). The main archwires are .0215 × .028 inch stainless, with mild bite sweeps, uncompensated at the front in order to allow some residual proclination of the upper and lower incisors. Note the distal crown inclinations of the lower canines and upper right lateral incisor, also the lingual apical positions of the lower laterals.



7

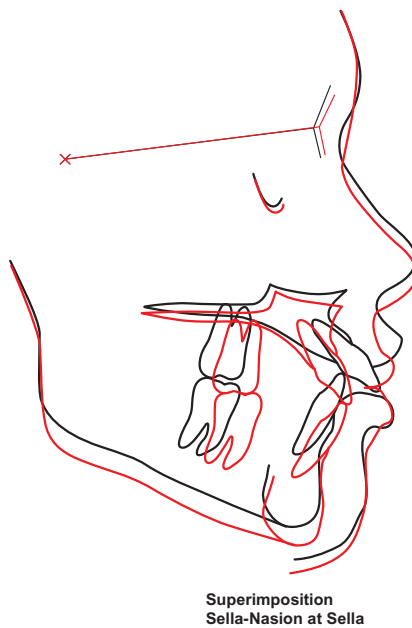
After 5 months of root uprighting, active treatment is complete. The proclination of the lower incisors has been maintained and a small space has been preserved distal to the upper right lateral incisor for the augmentation of its rather small crown.



Post treatment			
SKELETAL		TEETH	
SNA	° 85.5	Overjet	mm 1.0
SNB	° 83.0	Overbite	mm 0.0
ANB	° 3.0	UI/MxP	° 119.0
SN/MxP	° 5.5	LI/MnP	° 102.0
MxP/MnP	° 25.5	LI-APo	mm 4.5
LAFH/TAFH	% 57.0		

8

Facial contour has been improved by the reduction of the overjet and a pleasingly full profile has resulted.



9

The upper incisors show good torque control. The smile is well balanced.

Treatment

Treatment time = 1 year 1 month.

Routine adjustments = 9.

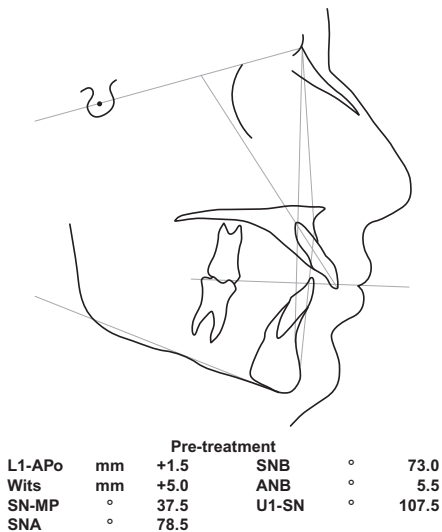
Main archwires used = 7 (4 upper, 3 lower).

Retention = upper and lower Hawleys, nights only (the lower may require long-term retention).

Case 3

A severe Class II division 1 malocclusion with a marked unilateral overjet treated with the Plus bracket

Treated by Dr Christopher Kesling



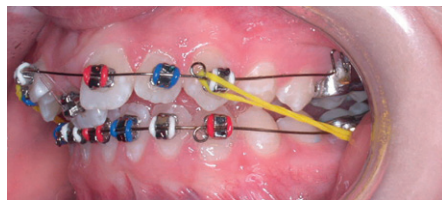
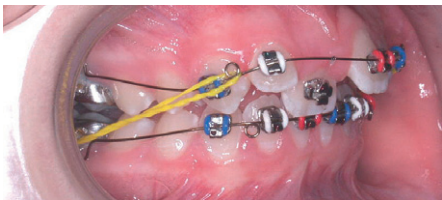
1

At age 11 years 10 months, a marked skeletal Class II case (Wits +5 mm) with a reduced lower facial height.



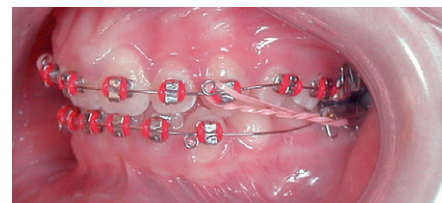
2

The overjet measures 6 mm, but the upper right central incisor is retroclined into a Class II division 2 relationship, with an increase in overbite. The buccal segments are towards a full unit Class II on both sides. The lower arch is acceptably aligned and the lower incisors are 1.5 mm in front of the A-Po line. Mandibular growth expectation should be favourable. A non-extraction approach is indicated.



3

Stage I uses high tensile stainless .016 inch archwires. The premolars are not bonded at the outset, because the overbite requires reduction. Anchor bends are placed to achieve this, using the round molar tubes. Very light (50 grams) Class II intermaxillary elastics will reduce the overjet. Elastomeric thread is preferred to an underarch for the alignment of the instanding central incisor, in view of the degree of displacement. Looped archwire stops in mesial contact with all four molar tubes (in lieu of plastic sleeves) prevent the premolars from crowding in response to the Class II traction.



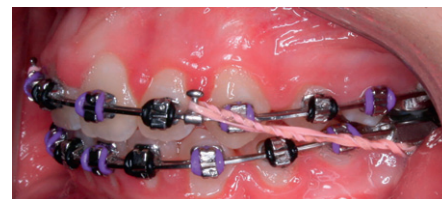
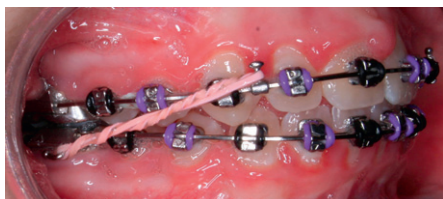
4

After 8 months, Stage I is virtually complete. The premolars are included over two visits, the uppers first, using the existing archwire.



5

At the next appointment, the lower premolars follow suit. Note that the main archwire routinely uses rectangular molar tubes from the time of premolar pickup. A Stage II .022 inch high tensile upper arch is fitted, in combination with a .014 inch nickel-titanium auxiliary archwire through the deep tunnels, to begin uprighting. (No torque will be transmitted as yet, however, as the main archwire wire is round.)



6

Following an interim Stage II .022 inch lower archwire (not shown) both arches are now into swept Stage III .0215 × .028 inch archwires to produce final torque and tip inclinations, powered by the .014 inch nickel-titanium auxiliary archwires in the deep tunnels.



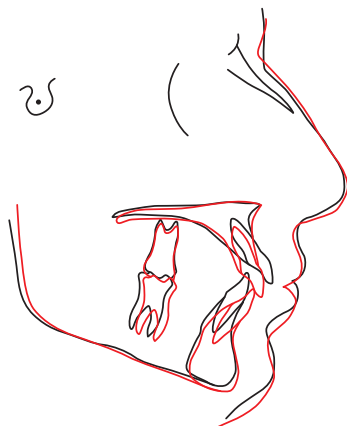
7

Treatment concludes after 6 months of torquing.



8

There is a considerable improvement in profile, helped by some positive mandibular growth.



Superimposition			
		Pre-treatment	Post treatment
		BLACK	RED
L1-APo	mm	+1.5	+3.0
Wits	mm	+5.0	+1.0
SN-MP	°	37.5	37.0
SNA	°	78.5	80.0
SNB	°	73.0	74.0
ANB	°	5.5	6.0
U1-SN	°	107.5	97.0
U1-OP	°		59.0



9

The lower incisors have proclined to 3 mm in front of A–Po.

Treatment

Treatment time = 1 year 5 months.
Routine adjustments = 11.
Main archwires used = 6 (3 upper, 3 lower).
Retention = Upper and lower removable retainers. 1 × 1.

Setting up Stage I

The base archwire	63
Anchorage bends	65
The auxiliary arch	65
Fitting the arches	65
Ligation of 'cuspid circles'	67
Anterior spacing	68
The distal arch ends	69
Intermaxillary elastics	69
Ligatures	69
'Straight Shooter'	70
Instructions for intermaxillary elastics	71

Setting up Stage I

Getting Stage I up and running is exactly the same with Plus as with the previously familiar Rx-1 brackets. The subsequent adjustments and checks are the same too.

The description that follows shows how to set up a case along the lines illustrated in the previous chapter. The malocclusion features a marked increase in overjet, an increased overbite, plus severe upper and lower anterior crowding. The reader is invited to assume that the typodont does not have a greatly raised maxillary-mandibular planes angle or a severe increase in lower facial height, and is therefore suitable for Class II intermaxillary elastic traction. Four first premolars are extracted (Fig. 8.1).

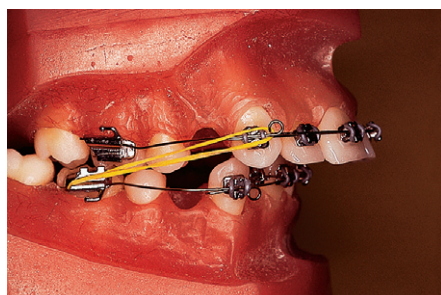
A question commonly asked is why such a case cannot be started more simply by means of nickel-titanium aligning archwires, before proceeding to stainless arches. The answer is that, while such wires do an excellent job aligning teeth, they are unable to control the vertical dimension, and particularly the molars, in the way that stainless steel can; neither can they support the use of intermaxillary elastics. The outcome would therefore be some loss of anchorage, by mesial molar migration, and a delay in implementing overbite and overjet reduction. Both are telling disadvantages in the more severe cases, particularly in the child patient. Besides, with experience, the following method becomes easy to carry out and, once set up, is easy to adjust and maintain without a change of archwires, over the 6 months or so necessary to obtain all first stage objectives.

The base archwire

.016 inch round high tensile stainless steel is the ideal archwire for Stage I, in both arches. This has the necessary resilience to withstand forces of occlusion, combined with the flexibility required to align mild tooth-to-tooth irregularities. It is particularly suitable for bite opening, offering a good range of action without excessive forces. The long established Special Plus grade Wilcock Australian wire continues to perform well, as does the more recent Bow-Flex® wire from TP Orthodontics (La Porte, Indiana, USA) (Fig. 8.2).



Fig. 8.2 High tensile stainless steel .016 inch wire should be used for the main archwires.



A



B



C

Fig. 8.1 Stage I – Placement of initial archwires in a crowded case with increased overjet and overbite. Four first premolars have been extracted.

The 'horseshoe shaped' archform, as used in straight-wire techniques, is not appropriate for the early stages of Tip-Edge, since use of an anchorage bend requires a straight posterior leg. Combining a buccal archwire curvature with a vertical anchor bend will cause the wire to 'wriggle' and rotate within the buccal tube, which will invite some molar rotation. Even if an initial molar rotation is present, a straight leg is the rule. No toe-in, in any shape or form, should ever be combined with an anchor bend.

The anterior curvature is interrupted by the 'cuspid circles', each of which should be placed mesial to its respective canine bracket. How close to the bracket will vary, according to alignment and available space. If the labial segment is crowded, the canines will need to drift distally to accommodate instanding teeth, so that the circles may be immediately mesial to the canine brackets at the start of treatment. This will minimize the need for subsequent repositioning of the circles distally along the arch. Conversely, if the incisors are spaced, it makes better sense to site the circles further mesially, to allow for the mesial movement of the canines, relative to the archwire, as the anterior space is gathered up.

Once the anteriors are aligned and in contact, the correct position for the circles will be just mesial to the canine brackets. However they should not be more than 2 mm in front of the brackets, bearing in mind that in the aligned segment the circles will be ligated to the canines by elastomeric modules (as described later in this chapter) which, if too stretched, could provoke mesial canine rotations.

If bending an archwire up by hand, begin with the anterior curvature. Each circle should then be formed so that the posterior section loops to the labial of the anterior segment and not vice versa. It should also be noted that the anterior archform curvature extends distal to the circles, across the face of the canines (Fig. 8.3).

When using Class II elastics and anchor bends, it is good practice to incorporate some overall expansion in the lower arch, as both components exert some elevating effect on the

molar tube, which may cause some lingual crown deflection. Five millimetres of expansion each side, measured across the molars, is generally adequate (Fig. 8.4), but this may be increased up to twice this amount in difficult deep bite cases. Even this does not amount to a strong expanding force in so light a wire. Since the upper molars will not be carrying intermaxillary elastics, only a marginal degree of archwire expansion will be required here (Fig. 8.5), simply to counteract the effect of the anchor bend.

A considerable amount of clinical time can be saved by using preformed archwires, which are fabricated from .016 inch Bow-Flex wire (Fig. 8.6). These are size graded according to the distance in millimetres between the cuspid circles, which can be ascertained in the mouth with a flexible plastic ruler, between the mesial surfaces of both canine brackets (Fig. 8.7). As a check, the circles can be tried across the front of the mouth without inserting the posterior archwire legs, before removing the sticky identification label. Arch length and arch width can then be tailored accordingly.

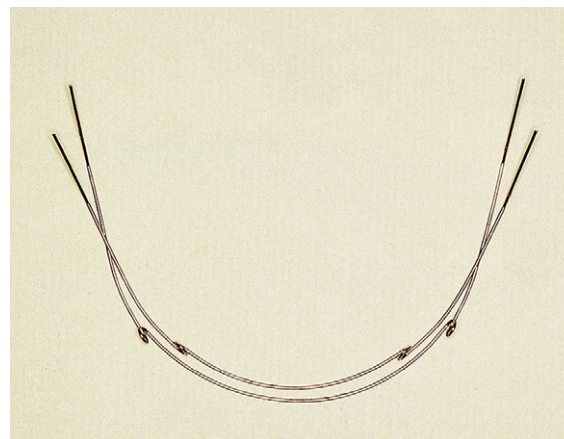


Fig. 8.3 Maxillary and mandibular archforms. Note the expansion of the lower.

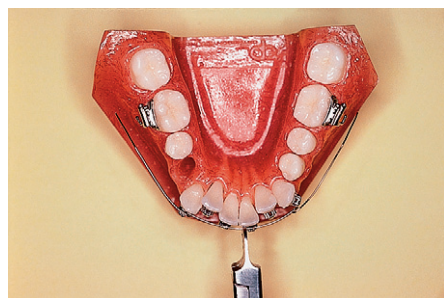


Fig. 8.4 Expansion of the lower archwire is advisable when using Class II elastics and anchor bends.

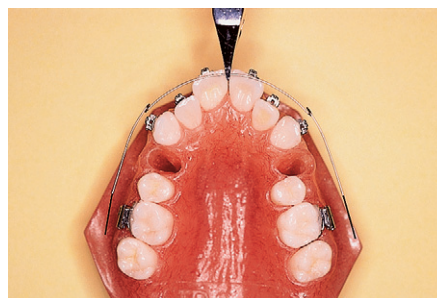


Fig. 8.5 If using anchor bends, a small amount of upper archwire expansion is needed.



Fig. 8.6 Preformed .016 inch high tensile archwires save operator time.



Fig. 8.7 The distance between the canine brackets determines the size of preformed archwire. Remember to compensate for any anterior spacing that may be present.

Anchorage bends

Correct positioning of the anchor bends should be approximately 2 mm in front of the molar tubes in both arches. The most accurate way of finding this is to mark the archwire at the mesial of the buccal tubes, then remove the arch from the mouth and make each bend 2 mm mesial to the marks. Placing the anchor bends further forward than this will cause them to obtrude occlusally and will also slightly lessen the amount of overbite reduction imparted to the anterior segment.

The anchor bends not only boost the anchorage available from the first molars, but also exert vertical control. The degree of the bends is therefore significant to both. There is no hard and fast rule as to the angle of the tip backs, but each needs to be assessed by the amount of intrusive deflection that the archwire produces at the midline. In a case where there is little or no overbite reduction required, the bends can be minimal: just enough to prevent the lower molars tipping mesially. This may amount to only a couple of millimetres of active gingival deflection at the midline. However, in a low mandibular angle deep bite case, the anchor bends can be made to work harder and will correspondingly generate stronger molar anchorage. The maximum vertical deflection permitted in such cases can be to the depth of the labial sulcus (Fig. 8.8). Although this might appear somewhat extreme, the intrusive force distributed between the six anterior teeth amounts to only 2 ounces (or 50 grams) in the upper and rather less in the lower.

The amount of anchor bend that will be required to achieve the desired amount of anterior arch deflection will also vary with the angulation of the molars. If the lower molars are tipped mesially, the amount of bend needed will be reduced accordingly. In fact, at the outset of treatment, the mesial crown angulations of tipped lower first molars will sometimes provide



Fig. 8.8 Even this degree of active intrusion in a .016 inch archwire delivers less than 50 grams (2 ounces) intrusive force to each segment.

sufficient anterior vertical deflection in themselves, without the addition of anchor bends at all. (Case 10 illustrates a similar scenario, where lower second molars have tipped mesially into first molar extraction spaces.)

Anchor bends should be used in the round molar tubes, with the premolars omitted from the appliance.

The auxiliary arch

The round nickel–titanium underarch, usually of .014 inch diameter, has the task of aligning instanding anterior teeth, and can usually be discarded at the first or second adjustment visit. Plus users should note that this underarch runs through the main archwire slots, never through any deep tunnels, for reasons given in the last chapter. It is best to use a curved section of wire cut from a preformed archwire (Fig. 8.9) rather than a straight section, which might rotate about its long axis. This sectional auxiliary should extend 3 mm distal to the canine brackets. This facilitates use of the ligature gun – described later under Straight Shooter® (TP Orthodontics Inc., La Porte, Indiana, USA) – and ensures that the free end will not escape and flick out from within its elastomeric module. For patient comfort, the distal ends of the sectional auxiliary should be turned 90 degrees to the lingual.

Fitting the arches

The auxiliary underarch goes in first, ligated to the instanding or rotated teeth (Fig. 8.10). With this in place, the tail of the main arch can be offered to the entrance of the round molar tube on one side (Fig. 8.11). This leaves a straight section of

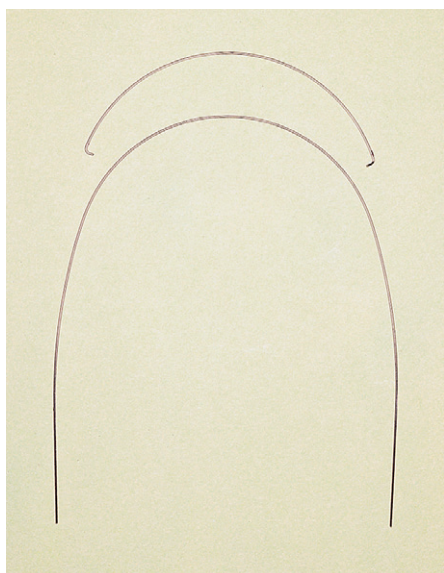


Fig. 8.9 The .014 inch nickel-titanium underarch should be cut from the anterior curvature of a preformed archwire.



Fig. 8.10 Fitting the .014 inch upper underarch. Ligate the instanding incisors first.

main archwire mesial to the canine bracket with the cuspid circle well clear, for easy use of the ligature gun. It also makes it easy to manipulate the underarch into the bracket, beneath the main arch, which holds it captive.

Once one canine is ligated, that side of the archwire can be slid distally to its correct position, whereupon the opposite canine can be secured by the same sequence. Finally, the remaining incisors are zapped with the ligature gun (Fig. 8.12).

Sometimes an incisor can be so severely displaced lingually that it cannot be bracketed correctly at the start visit, in which

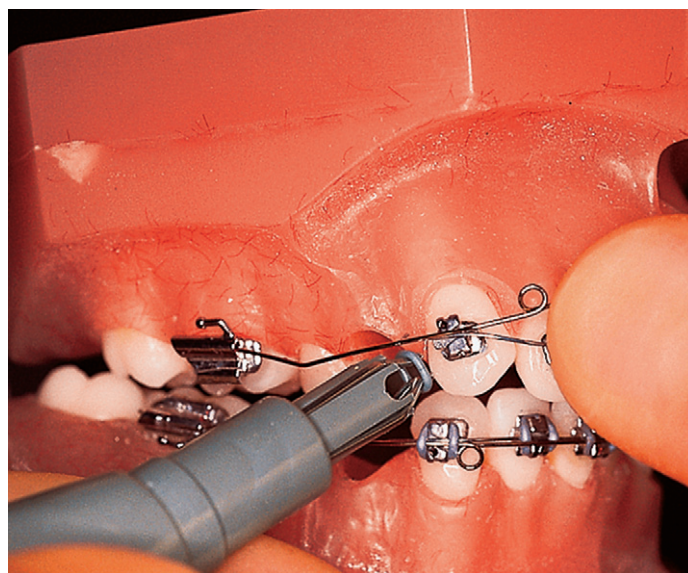


Fig. 8.11 Now insert the distal of the main arch into the entrance of the molar tube, on one side only. This facilitates ligation of the canine without interference from the cuspid circle, before sliding the archwire distally into place.

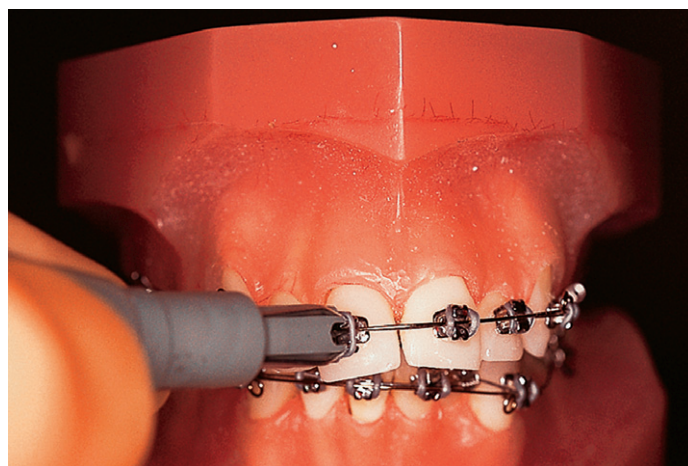


Fig. 8.12 Having done the same to the opposite canine, the remaining incisors are the last to be ligatured.

case an inexpensive bonded loop can be used initially. This can be discarded at the next adjustment, when a proper bracket can be placed. The nickel-titanium auxiliary arch can be loose tied if necessary, until full bracket engagement becomes possible. Alternatively, .020 inch elastic ligature thread can be tied around the main arch for preliminary alignment (Fig. 8.13). Although easier to insert, elastic thread tends to be unreliable and is rather less precise in the vertical dimension than an underarch.

Full bracket engagement of the canine is essential to security. This will prevent the underarch from escaping and flicking out

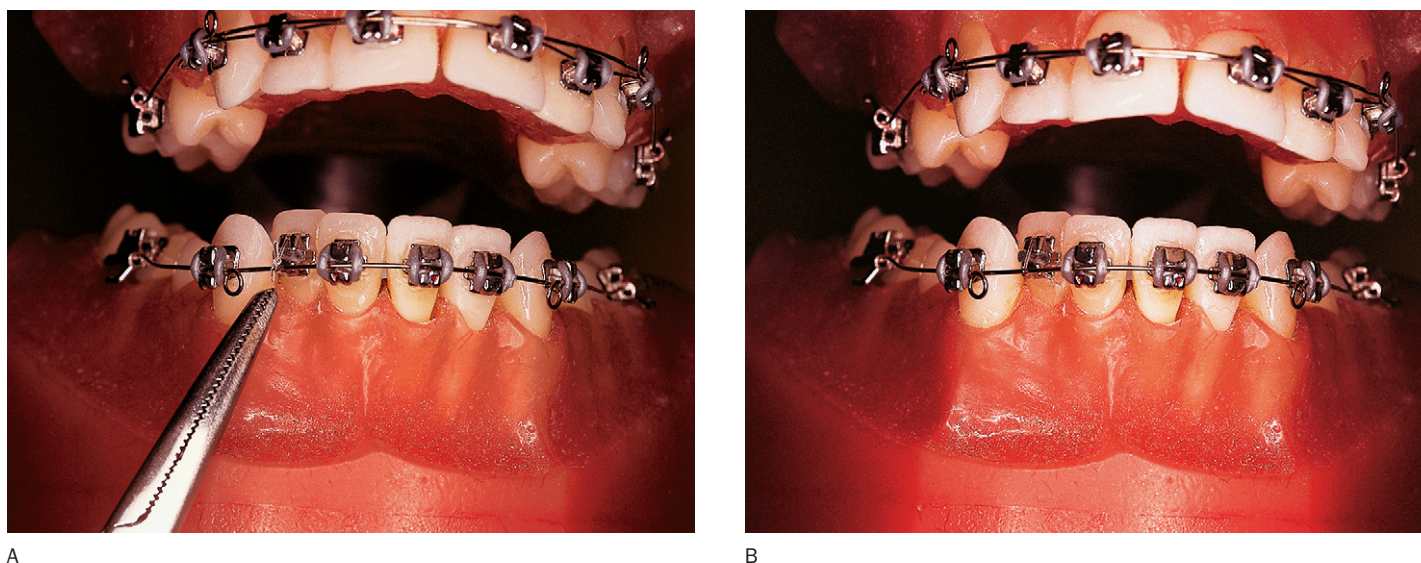


Fig. 8.13 (A) A big lingual displacement may initially need an elastic Zing String® (TP Orthodontics Inc., La Porte, Indiana, USA) tie through the vertical slot. (B) Once knotted, the tie can be rotated so that the knot hides behind the gingival tie-wing.



Fig. 8.14 (A) An incorrect cuspid tie. The elastic ligature lies beneath the archwire at the mesial. (B) A correct cuspid tie, with the elastic ligature labial to the archwire mesially, preventing mesial rotation. (C) Also correct, the figure-of-eight 'Swiss Twist'.

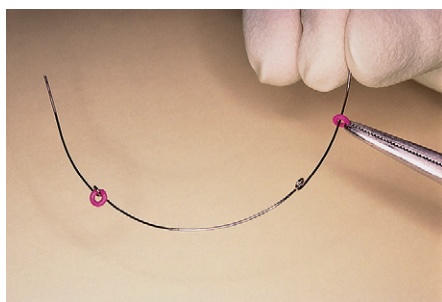
buccally, particularly in the lower arch. If this is not possible (usually due to a disto-lingual canine rotation) it may be necessary to use a wire ligature to the canine for the initial visit. The Plus orthodontist would be wrong to consider the deep tunnels of the canines as a safe haven for the underarch ends. This would exert root control on the very teeth that need to tip distally to accommodate the crowded incisors.

Ligation of 'cuspid circles'

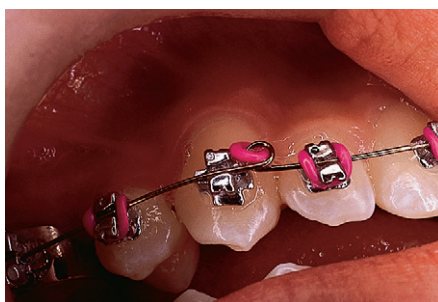
Mention was made in the previous chapter of subsequently ligating the canine brackets to the cuspid circles on the archwire. Obviously this is contraindicated while crowding exists in the anterior segment, as this would impede the distal canine migration described above, thereby preventing the alignment of the instanding incisors. However, once anterior alignment

has been achieved, each canine bracket should be ligated to its respective cuspid circle with an elastomeric, throughout the remainder of Stage I. As outlined in Chapter 6, this serves two purposes: the canines are prevented from unwanted further distal migration, so that the anterior segment will not become spaced; secondly, the archwire is stabilized laterally, and cannot swing from side to side. It follows that in a case with no irregularities in the anterior segment, ligation of the canines to the circles will be required from the very start of treatment.

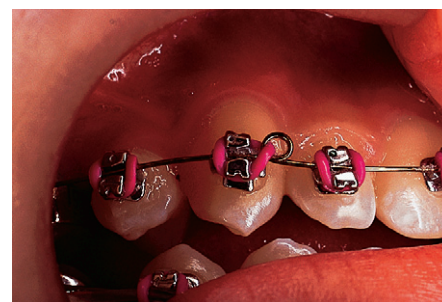
There is, however, a right and a wrong way of applying the elastomeric modules to secure the canines. Simply engaging each tie wing and cuspid circle direct, following arch insertion, is incorrect, because the elastomeric will find its way beneath the archwire at the mesial of the canine (Fig. 8.14A). This may result in a mesial rotation, particularly if the elastomeric is under stretch. Figure 8.14B and C both eliminate this risk by providing labial archwire coverage at both mesial and distal.



A



B



C

Fig. 8.15 (A) Before placement in the mouth, an elastic ligature can be slid along the archwire into the cuspid circle, from each distal end. (B) The cuspid tie hangs loose within its circle while other brackets are ligated. (C) Finally, the cuspid tie is engaged around its bracket with haemostat 'mosquito' forceps.



A



B

Fig. 8.16 (A) An E-9 intercanine elastomeric to close upper anterior spacing. (B) One month later.

Figure 8.14B is achieved by threading an elastomeric module on to the archwire from the back, before fitting the archwire in the mouth. The module should hang freely from within the cuspid circle (Fig. 8.15A). Then, following insertion of the archwire and ligation of the incisors (Fig. 8.15B), each module can be stretched around its respective cuspid bracket with haemostats (Fig. 8.15C). An alternative method is the 'figure of 8' (Fig. 8.14C), sometimes known as the 'Swiss Twist'. This can be placed after archwire insertion. It is easiest to engage the cuspid circle first with haemostats, before twisting the elastomeric through 180 degrees and hooking it around the tie wings.

Anterior spacing

If the incisors are spaced at the beginning of treatment (unlike our typodont), they need to be approximated so that all six anterior teeth in the segment stand together as a block. An

elastomeric chain might be the anticipated method, but its force values are less easily controlled than elastomeric 'E-Links', which come in a variety of lengths. Generally a size E-9 is appropriate for closing upper anterior spacing. The end links engage the canine brackets, just as with chain, while the intervening span runs through the incisor brackets, deep to the archwire. The incisor brackets are retained with elastomeric modules in the usual way (Fig. 8.16). This is less conspicuous than chain, and easier to keep clean. In such a case, the cuspid circles must be sited well to the mesial of the canine brackets, otherwise these will act as stops on the archwire, preventing the canines from coming mesially.

If the amount of anterior spacing is relatively small, it may not require an intercanine E-link. The elastic ligatures from the canines to mesial cuspid circles will shrink minor spaces under only light stretch. Particularly if an overjet is present, anterior space closure in the upper arch will happen anyway, due to the effect of the Class II elastics, without the help of an E-link.

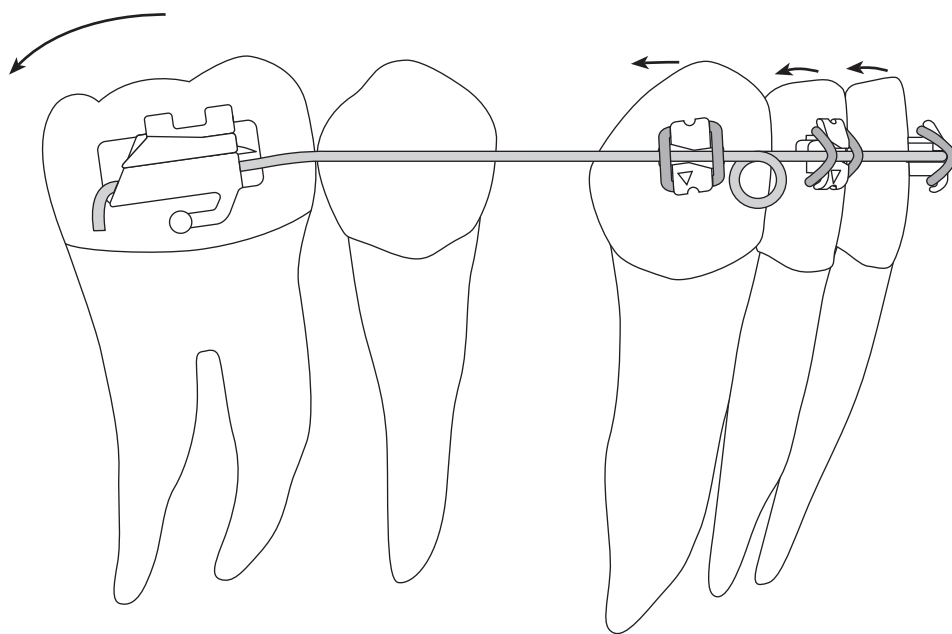


Fig. 8.17 Cinching the lower archwire ends tightly to the gingiva is wrong. If the first molar tips distally due to the anchor bend, it will drag the lower labial segment lingually.

The distal arch ends

Two millimetres of archwire should be left protruding distal to the lower molar tubes to accept the Class II elastics, and should be bent about 30 degrees to the lingual for patient comfort. The upper arch ends can be cut immediately distal to the tubes. It is important not to cinch the ends gingivally, particularly in the lower arch. This is because any distal tipping of the molars in response to the anchor bends will drag the archwire distally, which will impart retroclination to the incisors (Fig. 8.17).

Intermaxillary elastics

These require to be worn full time from the upper cuspid circles to the distal ends of the lower archwire.

Why, it might be asked, should the distal arch ends be preferred to the more obvious molar hooks? There are two reasons. Firstly, the vector of elastic force is more horizontal when used in this way, since the position of the hook increases the undesirable vertical vector of elastic force by being both further forward and more gingivally placed (Fig. 8.18). (The difference becomes even greater in extraction cases, when spaces close and arch length shortens.) Secondly, overbite reduction is arguably more effective with a more distal application of elastic to the molar, which better resists distal crown tip and therefore encourages a fuller expression of the anchor bends to the anterior segment.

It is absolutely essential to keep the elastic force light at all times – 50 grams or 2 ounces each side may be as little as one-sixth of that recommended by some straight-wire orthodontists, and is of course one major reason why Tip-Edge can escape the unwanted side effects of intermaxillary elastics, as explained previously. However, it needs to be stressed again that using forces in excess of 50 grams with Tip-Edge increases the risk of elongating the upper incisors, by overcoming the intrusive effect of the upper anchor bends, as well as provoking problems of lower molar control. The Tip-Edge orthodontist quickly learns the value of light forces, and will soon recognize that slow progress, if it occurs, is the result of poor compliance with the elastics, rather than inadequate forces.

Ligatures

Steel ligatures are only occasionally necessary in Tip-Edge, and then only at the start of treatment (or if using a derotating spring). An interim steel tie may initially be a safeguard against disengagement, where the archwire cannot be fully seated, or to obtain full bracket engagement of a nickel–titanium under-arch on a rotated tooth. However, these should be substituted for elastomeric ligatures as soon as possible, since the relative inflexibility of steel ligatures inhibits the free tipping of the brackets, and is therefore liable to increase anchorage in the wrong places.

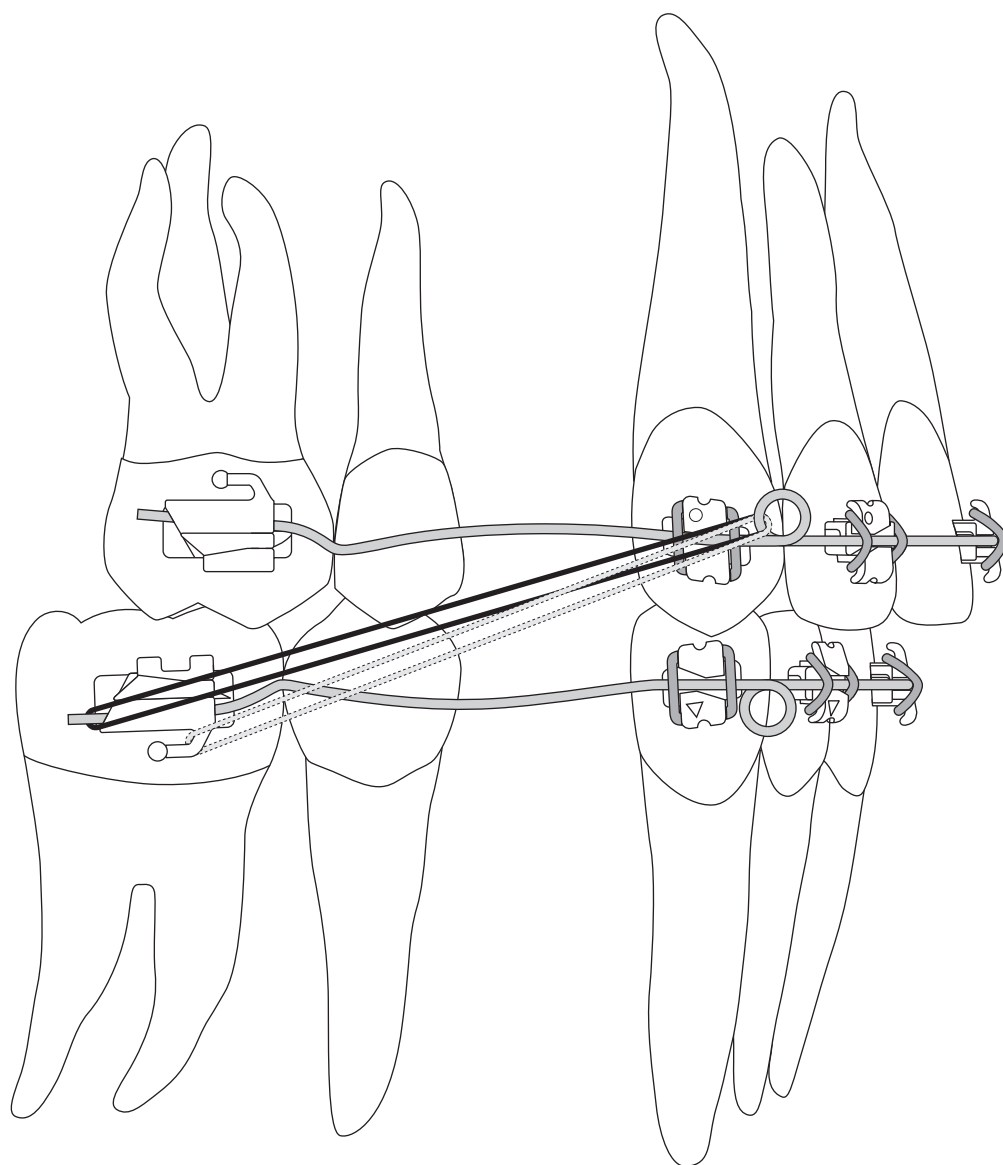


Fig. 8.18 There is a significant difference between the vertical force vector produced by Class II elastics worn to the distal arch end as opposed to the molar hook. The distal arch end is better.

‘Straight Shooter’

This ingenious ligature gun, invented by Dr Peter Kesling, is ideally suited to Tip-Edge, and a wider version can also be used with many edgewise type brackets. With experience, it convincingly upstages the traditional haemostat forceps for placing elastomeric modules, and greatly speeds adjustment visits throughout Tip-Edge treatment.

Made from autoclavable plastic, similar to that used on wingtips of supersonic aircraft, each elastomeric module is picked up from a flat surface or an adhesive Stickyring® (TP Orthodontics Inc., La Porte, Indiana, USA) (Fig. 8.19). The



Fig. 8.19 The Straight Shooter picks up from a flat surface (or Stickyring).

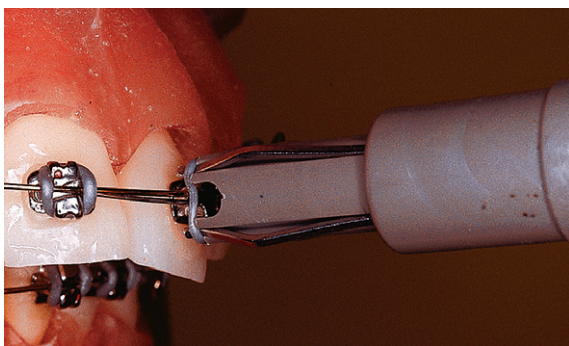


Fig. 8.20 The claws open as the trigger is squeezed.

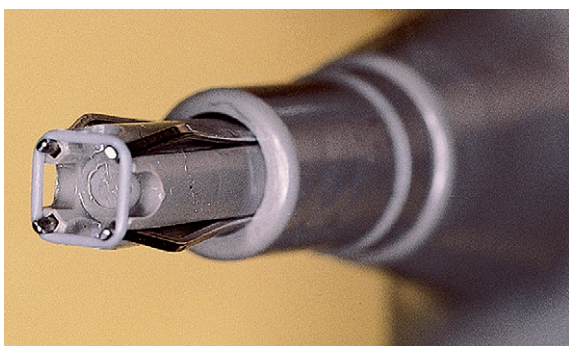


Fig. 8.21 The module is stretched around the tie wings.

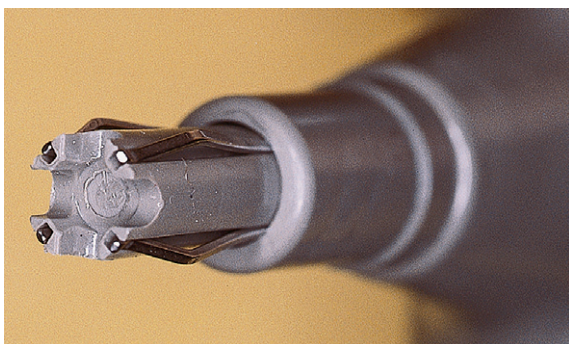


Fig. 8.22 The piston ejects the module . . .

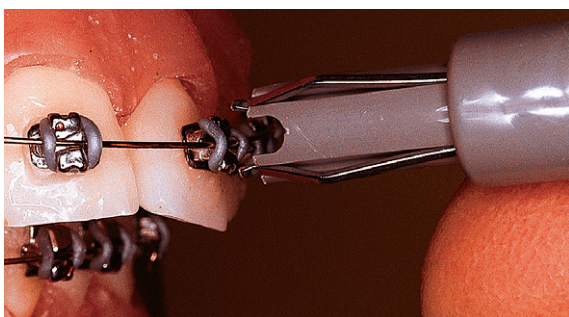


Fig. 8.23 . . . which contracts around the tie wings. Eureka!

Straight Shooter should then be placed over the bracket, at right angles to it, while progressively squeezing the trigger (Fig. 8.20). This separates the four claws to stretch the module around the outside of the tie wings (Fig. 8.21). At this point, the trigger is squeezed fully (Fig. 8.22), advancing the inner piston to expel the module from the claws, allowing it to contract securely around the tie wings (Fig. 8.23).

Apart from speed in use, the ligature gun places less pressure on the tooth than when stretching a module around a bracket by hand. It is therefore more comfortable for the patient and needs less concentration from the operator. There is also less risk of an accidental 'gingivectomy' by slipping off the bracket. Initially, however, it requires familiarization. It takes a few weeks of regular use to become an expert marksman!

Instructions for intermaxillary elastics

As orthodontists, we need to recognize that communication is of paramount importance in obtaining the co-operation of our patients. An appreciation by the patient of what is going on is essential to good compliance. Since intermaxillary elastics will be the 'power source' in the majority of Tip-Edge cases, a thorough explanation of their use is time well spent at the set-up visit. Otherwise, particularly as the elastic forces are so light as to be hardly perceived by the wearer, the patient may be tempted to regard them as an optional add-on to treatment, rather than the primary motive force.

The author's policy is to explain that the archwires do the straightening and provide a guidance pathway for the front teeth to follow, but actual movement of the front teeth backwards is done entirely by the patient, by wearing the elastics full time. A simple explanation of tooth movement follows, emphasizing that even very light elastic messages will signal the teeth to begin moving after 24 hours or so, whereas leaving the elastics off for even an hour will halt the process entirely, requiring many additional hours of wear to restart it. While not strictly true physiologically, this does impress upon the patient the big difference in progress resulting from 100% as opposed to 90% wear. The fact is that a 90% wearer will all too easily drop to 80%, and so on down the slippery slope of non co-operation.

The patient is given two packets of elastics, one to be used for routine replacement every night before bed time, the other to be carried with them wherever they go, for instant replacement in the event of loss or breakage, much as every car carries a spare wheel in case of a puncture. The elastics should only be removed for cleaning the teeth.

Every orthodontist will have his or her own way of reinforcing the message. An excellent protocol from a leading Tip-Edge practitioner (C. C. Twelftree, personal communication) goes as follows:

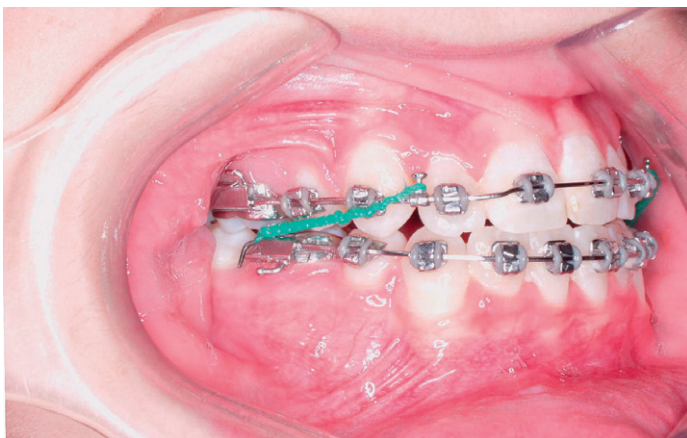


Fig 8.24 Some patients prefer to wear the elastics wound up – it is a matter of choice (Dr C. K. Kesling).

Patients are told to wear elastics all the time, even when eating. They may remove the elastics for cleaning only, but the elastics must be placed over a finger during this time. If elastics are placed on the basin or the end of a tooth brush they will occasionally be forgotten. I require elastics to be changed only when they break, to minimize force values, and this means that two or three elastics need to be kept with the patient at all times. These can conveniently be carried on a watch band or a safety pin. At the first appointment after appliance insertion, which is always one week later, the patient is intelligently quizzed regarding elastic wear to re-emphasize the instructions.

Some patients find elastics less obtrusive when coiled along their length. This can easily be achieved by the patient on insertion, simply by rotating the index finger within the elastic a few times before hooking it over the circle (Fig. 8.24).

Stage I checks

Stage I checks

The routine adjustment interval throughout Stage I is 6 weeks. At each adjustment visit, the following checks will be necessary:

- **Measure the overjet.** The normal expectation for overjet reduction in extraction cases will be 3–4 mm per visit. Non-extraction cases and adults may be a little slower. *Failure of overjet reduction is almost invariably due to partial elastic wear, which can be further confirmed by distal crown tipping of the lower first molars, since the anchor bends will no longer be balanced by the mesial elastic forces. Occasionally, the archwire ends protruding distal to the upper first molars may impact against buccally displaced upper second molars. If so, they should be shortened, or bent around the obstructing buccal surface.*
- **Observe the overbite.** The incisor overbite may take a visit or two to respond and the rate of overbite reduction varies according to the skeletal pattern and age of the patient. *If the overbite fails to reduce, the cause will be either poor elastic wear, as described above, or damage to the anchor bends. The latter can be checked by releasing the archwire from the anterior segment, while keeping it engaged in the molar tubes. The amount of vertical activity remaining in the wire at the front can then be observed.*
- **Molar widths.** These should be checked with dividers. *Lingual contraction of first molars suggests that the anchor bends are too strong, or that the archwire has been inadequately expanded. In the mandibular arch, it may also denote use of excessive elastic force. (In first molar extraction cases, lingual rolling of the banded second molars may require the patient to wear the Class II elastics to lingual hooks on the second molars by night, conventionally by day.)*
- **Check the cuspid circles.** Attention to these is generally only necessary during the initial treatment visits, when the incisors are being decrowded or anterior spacing closed. *If anterior space is refusing to close, the cuspid circles may be preventing the canines from being gathered into contact with the incisors, and will need rolling mesially. In severely crowded cases, the canine circles may require to be rolled distally to catch up with the canines, which will have migrated backwards to allow the accommodation of crowded incisors.*
- **Siting of anchor bends.** These should be maintained 2–3 mm in front of the molar tubes. Particularly during overjet reduction, the upper anchor bends are likely to need repositioning forwards, as the archwire slides distally through the molar tubes. *Allowing an anchor bend to enter a molar tube will cause binding.*
- **Distal arch ends.** For similar reasons, the arch ends distal to the molar tubes may lengthen and require trimming. Equally, it is important to make sure that each distal end is plainly visible and not too short. *If a distal arch end fails to protrude beyond the distal of the tube, it will generate friction within the tube and prevent free sliding.*
- **Distortion of the archwire.** This requires removal of the wire to assess accurately and rectify. The anchor bends should be reinstated to produce the correct degree of anterior intrusion. *A negligent patient should be cautioned to avoid hard substances, as repeated biting out of the tip-back bends will result in reduced anchorage resistance from the molars, as well as poor overbite reduction.*
- **Reassess the elastic tension.** As intermaxillary elastics take effect, the distance between the attachment points will inevitably reduce, resulting in a lesser degree of stretch. It will therefore be necessary to check the elastic forces on a strain gauge, and against clinical progress, replacing them with a smaller size if necessary, in order to maintain the ideal tension (50 grams or 2 ounces).

‘Power Tipping’ and the Protraction Arch

Power Tipping	79
The Protraction Arch	81
Case 4 A marked bimaxillary proclination on a Class II skeletal base with an increased overjet and overbite treated with the Plus bracket	84

‘Power Tipping’ and the Protraction Arch

Here are two techniques that are sometimes useful during Stage I to counteract specific problems. They are unrelated except inasmuch as they usually involve the lower labial segment. Power Tipping is a way of resisting lower incisor proclination during overbite reduction in extraction cases, or where the buccal segments are spaced. It is also able to upright incisors lingually over mandibular base with minimal loss of anchorage.

Conversely, the ‘Protraction Arch’ applies to the mildly crowded non-extraction lower arch, in which it encourages a small degree of proclination to facilitate anterior alignment.

Power Tipping

The danger of proclining lower incisors undesirably during overbite reduction, particularly where anterior crowding is present, must be recognized with any appliance. With Tip-Edge, as previously explained, projecting the lower front teeth labially during decrowding is less likely than with straight-wire type

appliances, because the lower canines are not held bodily by their brackets, and are therefore free to tip distally along the arch into available space.

The situation becomes more threatening, however, when the overbite is being reduced with an already proclined lower incisor segment. Here, by the simple laws of physics, it will be understood that the intrusive force from an archwire within a labially placed bracket acts along an axis that will be considerably labial to the centre of rotation of a proclined incisor (Fig. 10.1). If further proclination is to be avoided, a lingual component of force must be introduced to counteract the proclination. How might this be done?

In a conventional edgewise derived bracket, lingual incisor crown torque might be induced by means of a torqued rectangular archwire, assuming that the anteriors are sufficiently aligned to permit full bracket engagement. However, Tip-Edge brackets cannot achieve third-order torque against rectangular wire while in transitional angles of tip. It would, of course, be easy enough to generate lingual crown movement by the simple expedient of adding intramandibular traction along the arch,

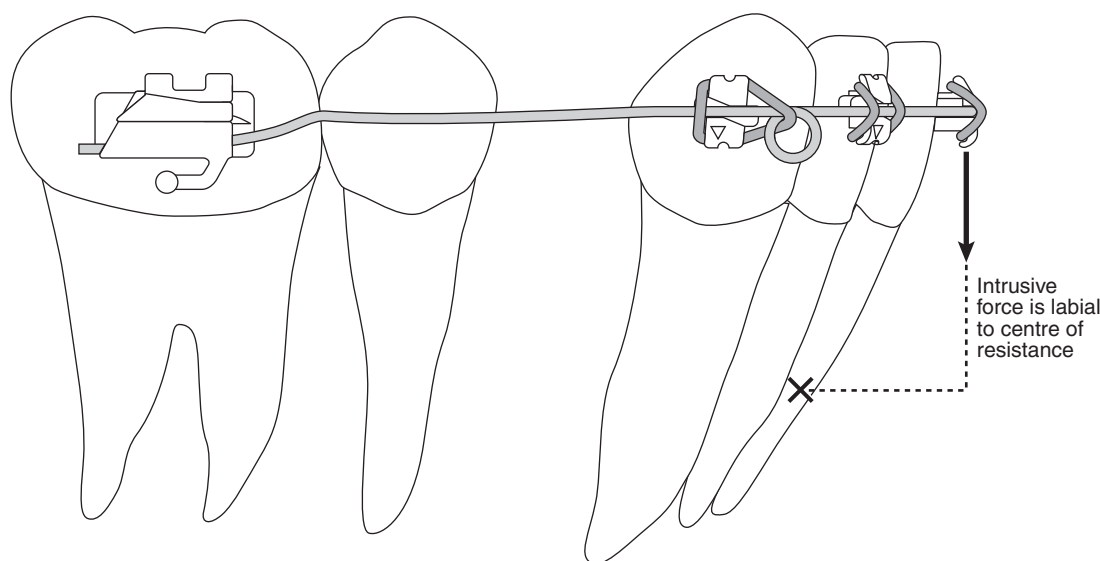


Fig. 10.1 An archwire exerting an intrusive force on an already proclined incisor may cause unwanted further proclination.

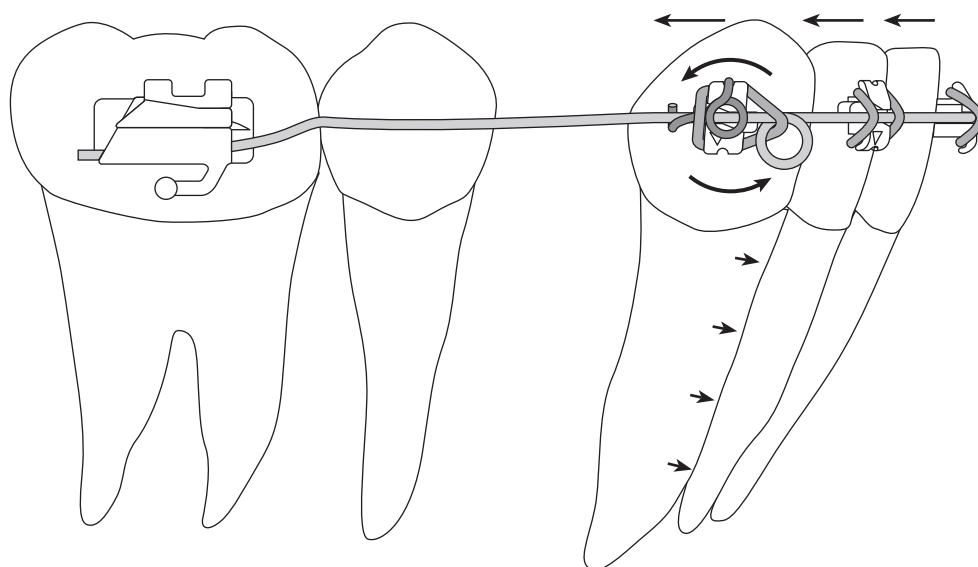


Fig. 10.2 Addition of Power Tipping to the lower canines induces lingual movement of the lower labial segment, by means of distal crown movement of the canines.

but this would introduce a reciprocal mesial force to the lower first molars, thereby dragging molar anchorage.

A much better way is ‘Power Tipping’, as illustrated in Case 4. Power Tipping is simple to apply and loses virtually no anchorage. It can be used to the existing Stage I archwire, and does not need to wait until incisor alignment is complete.

How does it work?

Power Tipping utilizes ‘reverse Side-Winder springs’ to induce distal crown torque to the lower canines, and hence distal retraction, which in turn uprights the lower anterior segment lingually (Fig. 10.2). It is essential to ligate the canine brackets to the cuspid circles during this process, assuming the anterior teeth are in alignment; otherwise the canines will retract along the arch without taking the lower incisors lingually, like a locomotive leaving its train behind. Obviously, use of Power Tipping presupposes that there is available space in the arch to the distal, into which the canines can migrate. If not, mesial root movement of the canines will result, instead of the distal crown movement intended. Power Tipping can be applied at any time during Stage I, when it becomes apparent that unwanted proclination is developing during overbite reduction. It does not require modification of the archwire.

The clinical scenario illustrated (Fig. 10.3) shows Stage I in progress during the treatment of a 12 mm overjet with a complete overbite in which the lower incisors were initially proclined. They now threaten to procline further under the intrusive influence of the anchorage bends, coupled with the use of Class II elastics. Four premolars have been extracted and the Stage I

assembly is as described in previous chapters, using .016 inch high tensile stainless archwires with anchor bends to the round buccal tubes. The premolars are omitted.

The addition of Power Tipping consists merely of inserting Side-Winder springs into the lower canine brackets. Since Power Tipping is designed to induce distal crown tip, rather than to correct it, the springs are fitted in the reverse direction to how they would be used later in Stage III (in an Rx-1 patient); in other words, the lower right canine will use a counter-clockwise spring, and the left canine a clockwise version. Note that both canines are secured to the cuspid circles by elastomerics.

Used in this way, the auxiliary springs may be regarded as little ‘motors’, gently propelling the crowns backwards by distal rotation which will, due to the canines being tied to the cuspid circles, cause the incisors to tip lingually as required. Full activation of the Side-Winders is not necessary to achieve this: about 45 degrees of activation is generally sufficient.

Four months later (Fig. 10.4), the lower anterior segment has inclined lingually, despite the full-time Class II elastics, due solely to the influence of the reverse Side-Winders. The clinical response does not appear to vary significantly according to whether first or second premolars have been removed. The same method can be used in non-extraction cases, only so long as there is available space mesial to the molars.

The principle of moving crowns by the application of root forces is by no means unique to Tip-Edge. While straight-wire appliances cannot employ Power Tipping electively in the present context it is, for example, accepted practice to assist buccal segment expansion with active buccal crown torque. It might be reasoned that Power Tipping induces some unwanted mesial apical movement on the lower canines, which must later



Fig. 10.3 Power Tipping applied to lower canines. Note the cuspid tie necessary to prevent each canine escaping distally without taking the incisors lingually.



Fig. 10.4 Four months later, the lower incisors have been uprighted lingually.

be reversed. No doubt this is so, but radiographic observation suggests that the degree of mesial root movement is very slight, compared with the amount of distal crown tipping obtained. Arguably the process is virtually 'anchorage free', particularly since no mesial forces are imparted to the first molars.

The Protraction Arch

This bears no relationship to Power Tipping. It concerns the non-extraction case where difficulty is being experienced gaining precise alignment of the lower incisors. Where a small amount of proclination of the incisors is deemed permissible, a protraction arch will readily achieve this to facilitate alignment. Its use is confined to mildly crowded situations.



Fig. 10.5 A multi-looped 'gated' archwire is effective at unravelling crowded incisors but is difficult for the patient to tolerate.

The normal method of alignment by a nickel-titanium underarch or an elastic thread may struggle to produce detail alignment where the contacts are very tight, and particularly in the older patient. Previously, the accepted method was to use multi-looped stainless archwires with vertical 'goalposts' to introduce local flexibility (Fig. 10.5). These loops could also be expanded laterally to gain a little extra space for alignment. Such archwires were a difficult introduction for the patient to tolerate from the initial visit. Vertical loops are difficult to keep clean and they reduce control of molar width and overbite reduction. The protraction arch is much simpler, more comfortable and easier for the clinician to manage, and should almost entirely eliminate the need for vertical loops.

It is fabricated from the same wire, .016 inch high tensile stainless, as normal in Stage I. The difference comes in the placement of the circles. Instead of siting these mesial to the canines, each circle needs to be at least 3 mm distal to the canine bracket, along the straight section of the buccal segment (Fig. 10.6). At the time of writing, protraction arches are not available preformed. The circles face gingivally, as usual, but some operators prefer to bend them with the distal leg to the lingual, which makes them easier to hook into from the distal. Protraction is activated by means of an elastomeric module stretched between each canine bracket and the circle behind it (Fig. 10.7). As the elastomeric contracts, the archwire will be drawn forwards through the molar tubes, making more wire available at the front, which allows the incisors to align onto a bigger curvature (Fig. 10.8). This they do surprisingly readily, minor irregularities frequently ironing out under the influence of elastic ligatures alone. More crowded situations might require an underarch or elastic ties to help alignment.

The protraction arch works whether or not the premolars are bonded and is not therefore a factor in making this decision.

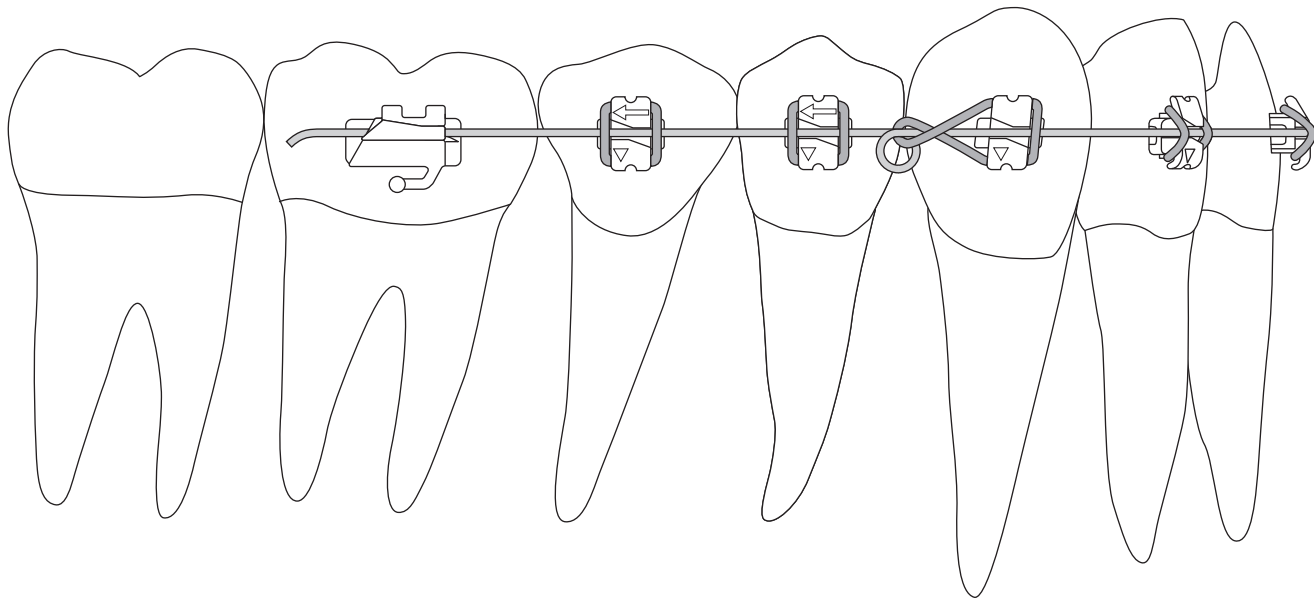


Fig. 10.6 A Protraction Arch will make additional space available for mildly crowded lower incisors. Activation depends on the contraction of the elastomeric. Note some excess of wire distal to the molar tube, necessary to allow protraction.

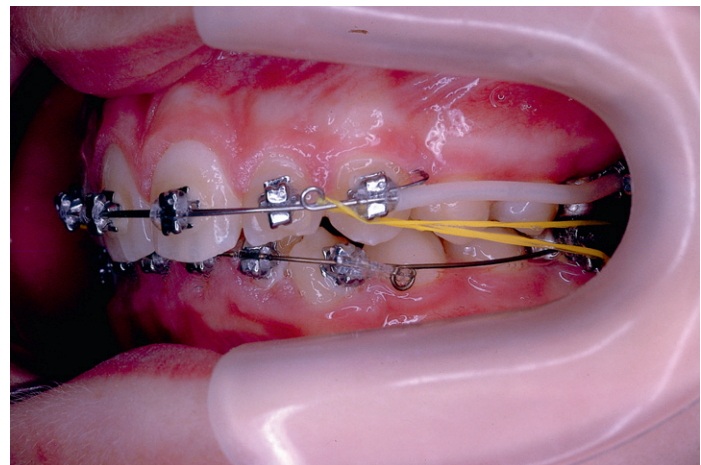
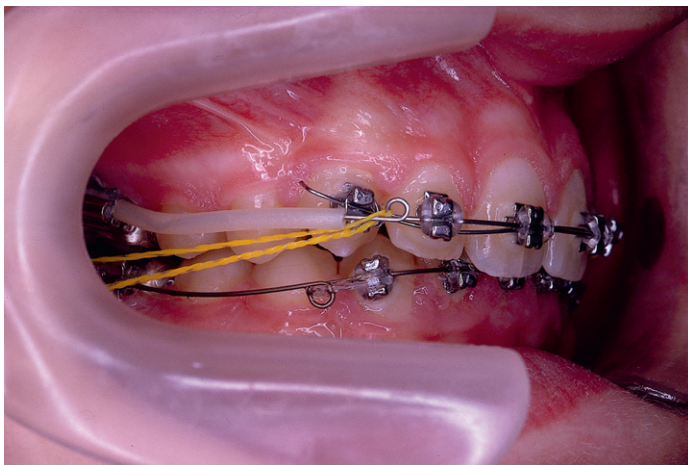


Fig. 10.7 Mildly crowded lower incisors at the time of traction arch placement. Overbite reduction continues as normal.

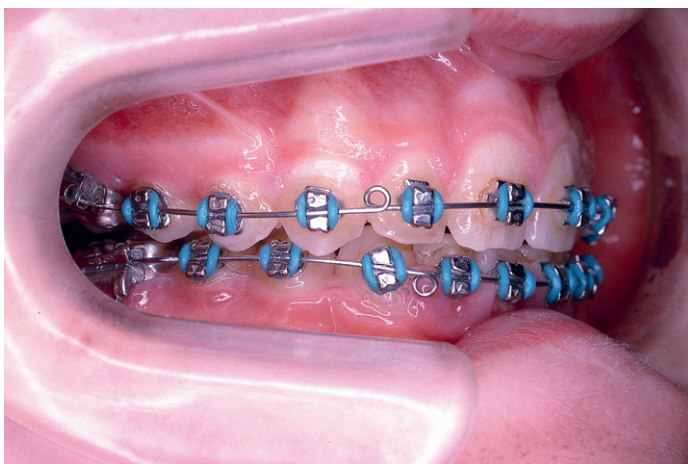


Fig. 10.8 The overbite has reduced, with alignment, allowing a smooth transition into .020 inch Stage II archwires.

Overbite reduction can progress unhindered, in which case anchor bends may be used in the round molar tubes in the usual way, with premolars excluded. If a longer range of action is required, the circles may be placed somewhat further distally than described, in which case elastic thread or a small e-link can harness the circles to the canine brackets instead of modules. If the premolars are already included, the circles cannot be placed as far distally without impacting the first premolar bracket. They may therefore need rolling further distally, at an

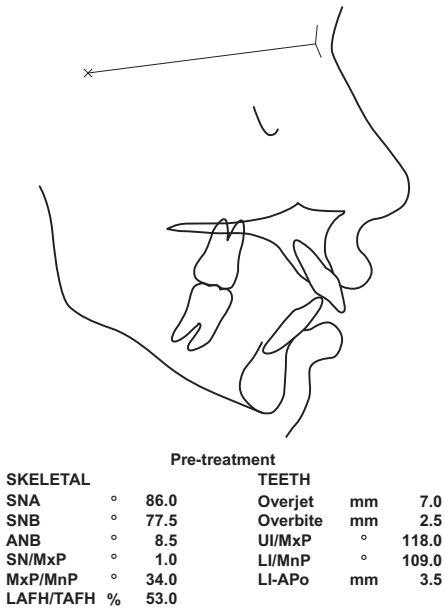
adjustment visit, to regain sufficient distance from the canine bracket to reactivate the protraction.

Because the action of the elastomerics is to protract the archwire mesially through the molar tubes, it follows that a more than adequate straight length of wire must be available distal to each molar tube, ready to be fed mesially. The distal end may be turned lingually for patient comfort, but at an appropriate distance from the distal of the tube. Cinching the archwire back thoughtlessly will prevent its action completely.

Case 4

A marked bimaxillary proclination on a Class II skeletal base with an increased overjet and overbite treated with the Plus bracket

Treated by Dr Joy Hickman



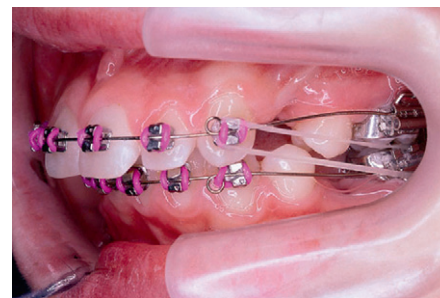
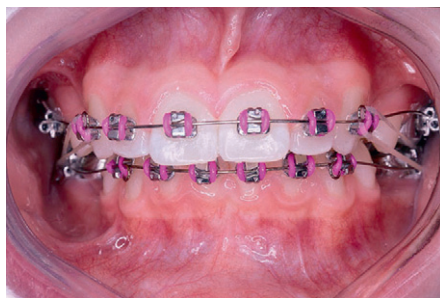
1

At age 11 years 7 months, a Class II case with typical lip incompetence associated with proclined upper and lower incisors. The lower incisors are in front of the A-Po line. The maxillary-mandibular planes angle is slightly raised at 34 degrees and the ANB angle is 8.5 degrees.



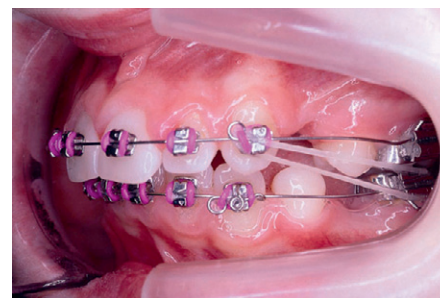
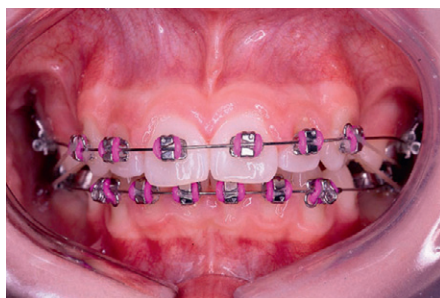
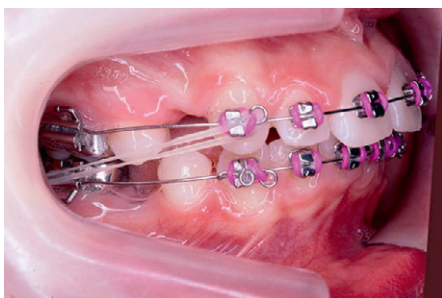
2

The overjet measured 8 mm clinically. However, since the lower incisors require to be uprighted on mandibular base, the overjet will require to be reduced to the corrected lower incisor position, thereby increasing the anchorage requirements of treatment. Extractions are indicated to allow the lower anterior segment to go lingually to ensure stability, and a greater amount of space will be required to accommodate the reduced overjet. The extraction pattern is upper first and lower second premolars.



3

Stage I .016 inch high tensile stainless archwires begin overbite and overjet reduction. The premolars are not bracketed, so as not to impede the effectiveness of the anchor bends, in round molar tubes, to reduce the overbite. Light (50 grams) Class II intermaxillary elastics, worn full-time, will reduce the overjet and aid overbite reduction. The lower anterior teeth are not crowded; consequently the canine brackets are ligated around the cuspid circles to prevent spacing. However, the upper fronts are a fraction crowded. Here, therefore, the canines are free to drift a little distally.



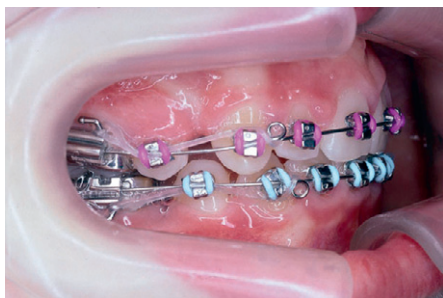
4

As described in Chapter 10, applying an intrusive bite opening force to proclined lower incisors may provoke further proclination. Here is a good example of Power Tipping. Note the 'reverse' Side-Winders (arms facing distally) in both lower canines. These will induce distal crown tipping towards the extraction spaces. The canines remain attached to the cuspid circles to ensure that the lower incisors go lingually as the canines go back. The upper canines are secured to their archwire circles, now that the incisors are precisely aligned.



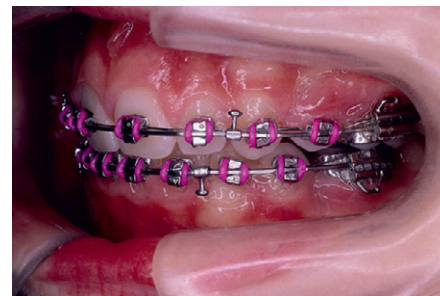
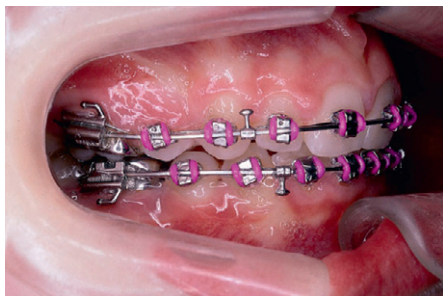
5

After 5 months of treatment, the overjet and overbite have been reduced. There is incisor contact above the lower brackets. It is time to pick up the premolars. Bite sweeps replace the anchor bends in the existing archwires, now inserted into the rectangular tubes. See how the mandibular labial segment has been uprighted lingually by the Power Tipping, without any intramandibular traction, hence with negligible loss of anchorage.



6

At the next visit, space closure begins along .020 inch high tensile stainless archwires, swept to maintain overbite reduction. Size 5 E-links in all four quadrants will shrink the spaces with retractive mechanics. (No brakes are indicated in this case due to the initial bimaxillary protrusion.)



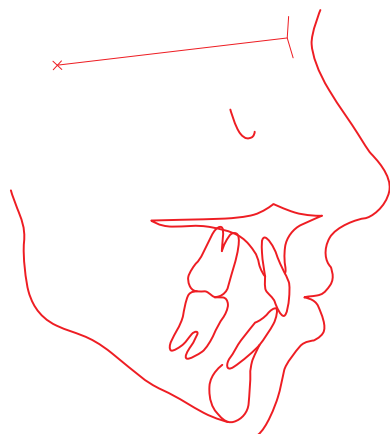
7

7 months into treatment, Stage III uses .0215 × .028 inch stainless archwires, swept and compensated. The deep tunnel nickel-titanium uprighting wires are .014 inch in the upper, but in the lower only a .012 inch is used initially, due to the degree of crown tipping. This will be upgraded to a .014 inch nickel-titanium 3 months later (and the upper to a .016 inch latterly). To assist uprighting of the upper second and lower first premolars, the distal ends of the deep tunnel auxiliary wires lie in the upper round tubes and the lower molar occlusal tie-wings.

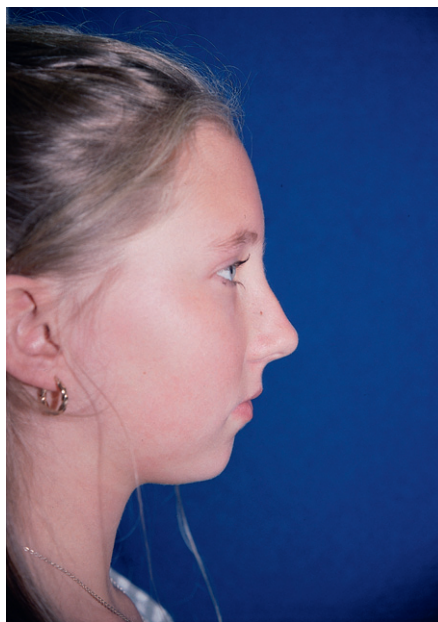


8

Treatment is complete in 1 year 7 months.

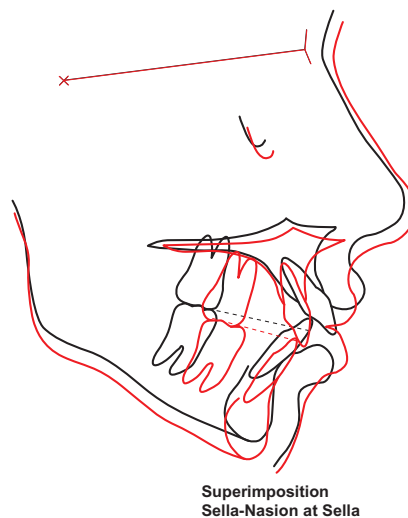
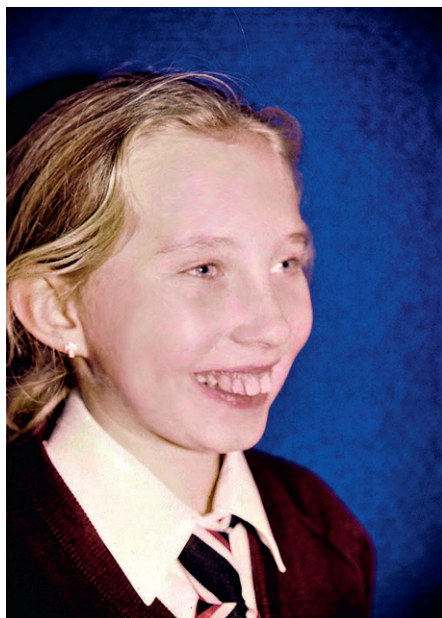


Post treatment				
SKELETAL		TEETH		
SNA	°	85.0	Overjet	mm 2.5
SNB	°	76.5	Overbite	mm 1.0
ANB	°	8.5	UI/MxP	° 101.0
SN/MxP	°	4.5	LI/MnP	° 102.0
MxP/MnP	°	31.5	LI-APo	mm 1.0
LAFH/TA FH	%	53.5		



9

There is a pleasing improvement in appearance, with easier lip contact.



10

The lower incisors have been retracted 7 degrees. There has been forward growth of the mid-face, but mandibular growth has not been favourable.

Treatment

Treatment time = 1 year 7 months.
Routine adjustments = 11.
Main archwires used = 6 (3 upper, 3 lower).
Retention = Upper and lower removable retainers.

Stage II

Objectives	91
Timing for Stage II	91
Aligning the premolars	91
Stage II archwires	93
Space closure	93
‘Applying the brakes’	94
Centreline correction	94
Derotation of first molars	96
Levelling of first molars	96
Continuing crossbite correction	96
Maintenance of Stage I corrections	97
Case 5 A mild Class II division 1 malocclusion with increased overbite and lower arch crowding with centreline shift treated with the Plus bracket	98
Case 6 A severely crowded Class II division 2 malocclusion on a marked skeletal II base treated with the Rx-1 bracket	102

Objectives

1. Closure of residual spacing. According to operator choice, this may be either by retraction of labial segments or by protraction of buccal segments.
2. Correction of centrelines.
3. Derotation of first molars.
4. Levelling of first molars.
5. Continuing crossbite correction.
6. Maintenance of Stage I corrections.

The second stage is easy to set up and is generally the briefest of the three stages, seldom exceeding 4 months, except perhaps in enforced first molar extraction cases (see Case 10) where there may be relatively large extraction spaces to close. In non-extraction cases, it follows that Stage II may amount to little more than accurate lining up, with .020 inch archwires, prior to the final rectangular Stage III phase. Whether using Plus or Rx-1 brackets, the handling and technique throughout Stage II is the same.

Timing for Stage II

Irrespective of the starting malocclusion, the second stage should begin synchronously, in both arches, as soon as the first stage objectives have been met. In practice, this means when enamel-to-enamel contact has been achieved between upper and lower incisors, above the lower incisor brackets, together with anterior alignment. At this time, in a deep bite case, the vertical battle will have been won, so that the anchorage bends can be dispensed with, in favour of conventional vertical 'sweeps' in the archwires, in order to maintain overbite reduction during space closure. In fact, Stage II largely follows straight-wire practice, but with the significant advantage, particularly in extraction cases, that the orthodontist can choose between protractive and retractive mechanics, according to whether or not Side-Winder 'brakes' are placed on the canines.

In all cases, the premolars should be included prior to the start of Stage II.

Aligning the premolars

In cases where the initial overbite was not significantly increased, the premolars will have been bonded from the start of treatment, and will already have been aligned during the first stage. However, in increased overbite cases, where Begg-derived mechanics have been used in Stage I, the premolars will have been omitted, and will require to be picked up and aligned at a pre-Stage II visit.

The premolar brackets should be selected with reference to the direction of tooth tip to be accommodated within the bracket, remembering that the second premolar, in a first premolar extraction case, is the exception tooth that comes the opposite way, with mesial crown tip toward the extraction space. A full guide to selection is described in Chapter 6.

The procedure for a deep bite case at the pre-Stage II visit is routine and consists of the following simple steps:

- Remove the .016 inch stainless archwires.
- Bond the premolars.
- Using the same archwires, remove the anchorage bends and replace them with vertical bite sweeps, to retain the overbite reduction previously gained. In the upper arch, this will be an increased curve of Spee, and an inverted curve of Spee in the lower, much as in straight-wire techniques.
- Re-insert the archwires, but into the rectangular molar tubes, which will be used for the remainder of the treatment.

A clinical illustration of the above can be seen by comparing Figure 11.1 with Figure 11.2.

The same .016 inch high tensile stainless archwires, as used throughout Stage I, generally have sufficient flexibility to align the premolars within a 3-week interval. However, there are cases which may require additional help. If a premolar is submerged, for instance, it may not be possible to enter the rectangular molar tube at the pickup visit. It may therefore be necessary to place the archwire in the more gingival round tube, elevating it to the rectangular tube some 2 weeks later.

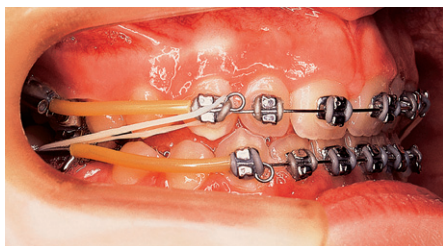


Fig. 11.1 Stage I is complete. It is time to pick up the premolars.



Fig. 11.2 The same archwires now align the premolars to the rectangular molar tubes, bite sweeps replacing the former anchor bends.

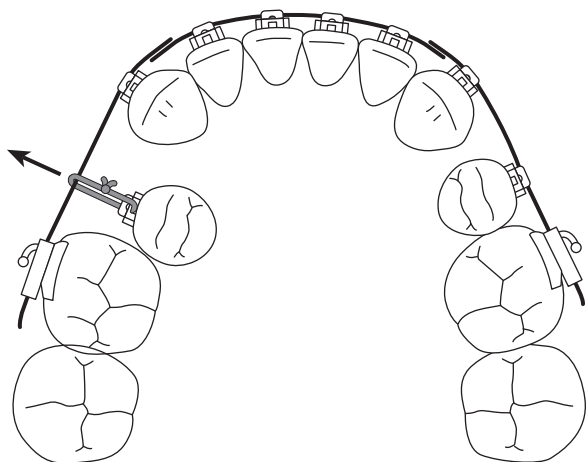


Fig. 11.3 A lingual premolar can be corrected with .020 inch elastic thread.

Another way to deal with wayward premolars is elastic thread, which can be tied through the vertical bracket slots and out to the archwire (Fig. 11.3). This is particularly effective with lingually displaced teeth. Rotated premolars can be corrected with elastomeric E-Links or chain: in the case of a mesial rotation, the elastomeric can run from bracket to molar hook, while a distal rotation will be handled in the opposite direction, routing the elastomeric to the cuspid circle (Fig. 11.4). It is

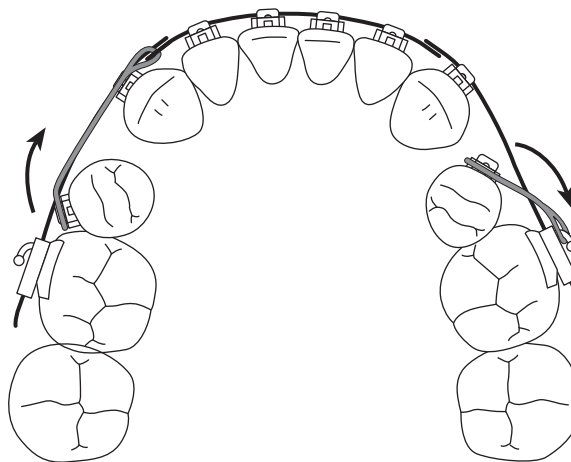
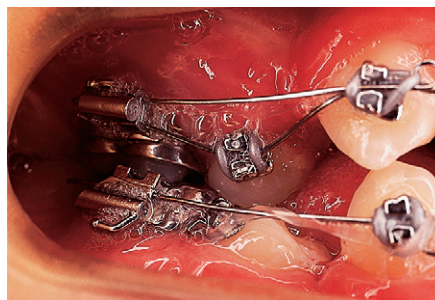
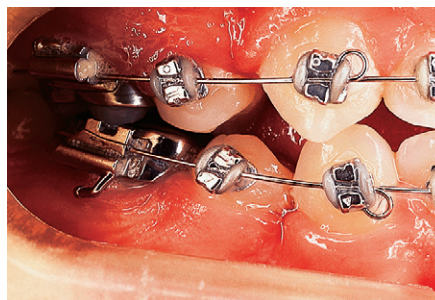


Fig. 11.4 Correction of premolar rotations with elastomeric E-Links: a distal rotation can be linked forward to a cuspid circle (left) and a mesial rotation backwards to a molar hook (right).



A



B

Fig. 11.5 (A) A .014 inch nickel-titanium underarch can be used to derotate a lingual rotated premolar to the rectangular molar tube. (B) This correction frequently takes only a month.

seldom necessary to use lingual attachments, although these are a further option for severe rotations.

Just occasionally, we all encounter the awkward premolar that has a combination of problems, being lingually displaced as well as rotated. Although rarely necessary, the nickel-titanium 'underarch' is worth remembering. This can be used sectionally beneath the main archwire if the problem is unilateral (Fig. 11.5A), or one can use a full auxiliary arch, worn

'piggy-back' beneath the main archwire. Either way, the premolars need to align to the rectangular molar tubes, the underarch using the rectangular tube with the main archwire temporarily sitting in the round tube. At the following visit, .020 inch archwires should readily engage the rectangular tubes to begin Stage II (Fig. 11.5B). On no account should a nickel-titanium arch be used to align premolars at the end of Stage I without the security of the stainless main arch, as this would invite loss of control elsewhere, such as relapse of overbite and overjet.

Summary of molar tube usage

- Round molar tubes are only used during Stage I in increased overbite cases, when employing Class II elastics and anchorage bends. The premolars will be unbonded. Active anchorage and bite opening bends should not be used adjacent to bonded premolars, or in rectangular tubes.
- As soon as the premolars are bonded, the rectangular tubes are used.
- All subsequent archwires, irrespective of whether round or rectangular, use the rectangular tubes.
- The use of round tubes to accommodate the deep tunnel auxiliary in Plus Stage III will be described in Chapter 17.

Stage II archwires

As an intermediary wire between the flexible .016 inch stainless first stage archwires and the rigid but passive .0215 × .028 inch rectangular stainless archwires used during the third stage, the author's preference for Stage II is .020 inch high tensile stainless archwires. These are stiff enough to maintain vertical and horizontal control during space closure, but are also sufficiently flexible for derotation of the first molars at the end of the stage.

It is however possible to use .022 inch stainless archwires, which will slide through the rectangular molar tubes without undue increase in friction. There may be occasional indications

for using these archwires through Stage II, where the added stiffness (nearly one-third greater than .020 inch wires) can be useful:

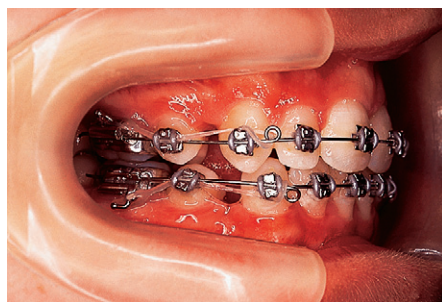
- In the maxillary arch in crossbite cases, where maxillary buccal segment expansion is required.
- In first molar extraction cases, where the heavier archwire offers better labio-lingual control of the second molars and increased resistance to mesial tipping, particularly in the mandibular arch.

The reader will note from Cases 1, 3, 5, 7 and 12, that Dr Christopher Kesling retains a preference for .022 inch archwires routinely in Stage II.

Space closure

As in Stage I, the cuspid circles serve as traction hooks. Buccal segment spacing can be closed very easily by applying elastomeric E-Links from the cuspid circles to the molar hooks (Fig. 11.6). Space closure is greatly facilitated throughout Stage II by the design of Tip-Edge brackets, as described in Chapter 3, whereby the binding that causes friction with conventional brackets is eliminated. Once again, this is because the teeth are free to tip; also the vertical slot dimensions will have opened up during translation in Stage I. In addition, it should be noted that the archwire itself will be moving distally during retraction, as it travels through the molar tubes, taking the bracketed teeth with it. The only exception will be the second premolar coming mesially into a first premolar extraction space, which will slide freely along the archwire with little resistance.

One of the great features available to the Tip-Edge orthodontist, when closing buccal segment spacing, is the ability to choose between retraction of the labial segment or protraction of the posterior segment. This is an invaluable aid for the optimal positioning of the anterior segments for profile and stability considerations. The orthodontist who uses edge-wise derived brackets cannot have this choice between free



A



B



C

Fig. 11.6 A retractive Stage II set up with .020 inch stainless archwires and E-6 elastomerics to close spaces in all quadrants. This is the same case as shown in Figs 7.1, 7.2 and 7.4, now 8 months into treatment.

tipping and bodily anchorage. With Tip-Edge, it is simply a matter of adding Side-Winder 'brakes'.

'Applying the brakes'

The principle of 'braking', as a feature of variable anchorage, has been described in Chapter 2, and is well illustrated in Case 11. Essentially, a gently active Side-Winder can be placed on a canine to induce a distal root movement, anterior to the space to be closed, in each quadrant to be 'braked' (Fig. 11.7). This will significantly increase anterior anchorage, hence resistance to retraction, and so favour protraction of the posterior teeth into the space remaining. While the canine is the most common choice as a braked tooth (partly because it offers the largest root area, and also because it frequently requires the most uprighting), a distally inclined first premolar can also be used as a braked unit, as in Case 11. Indeed a second premolar may be equally suitable in a first molar extraction case, as illustrated in Case 10.

Braking is frequently used bilaterally, more commonly in the lower arch in Class II cases, and in the upper in Class III cases. Brakes can easily be applied or removed at any treatment visit, according to the progress of the case. They can also be used unilaterally, as will be seen in the next section, to protect a centreline, or to correct a centreline discrepancy.

Centreline correction

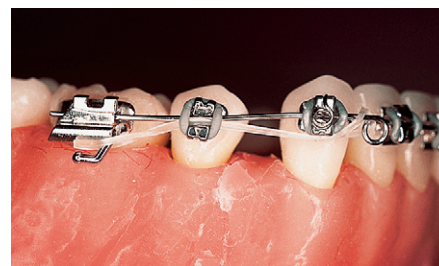
Awareness of centrelines is essential during Stage II, not least because midline discrepancies are most easily corrected while there is still space available in the dental arches. It stands to reason that if the centrelines are not coincident by the time all

spaces are closed, there will inevitably be some disparity in the buccal segment occlusion.

Centrelines are more labile with a bracket that allows teeth to tip, but by the same token, they are also much easier to correct. With straight-wire appliances, each anterior unit is essentially a rigidly held 'anchorage unit', requiring to be driven individually to its required position, with appreciable lateral anchorage consequences. By contrast, with Tip-Edge, an entire anterior segment can readily be persuaded to 'flow' laterally



A



B

Fig. 11.7 'Braking' on a lower canine. A gently active clockwise Side-Winder (A) will increase anterior anchorage in the lower right quadrant, when hooked up to the archwire (B).

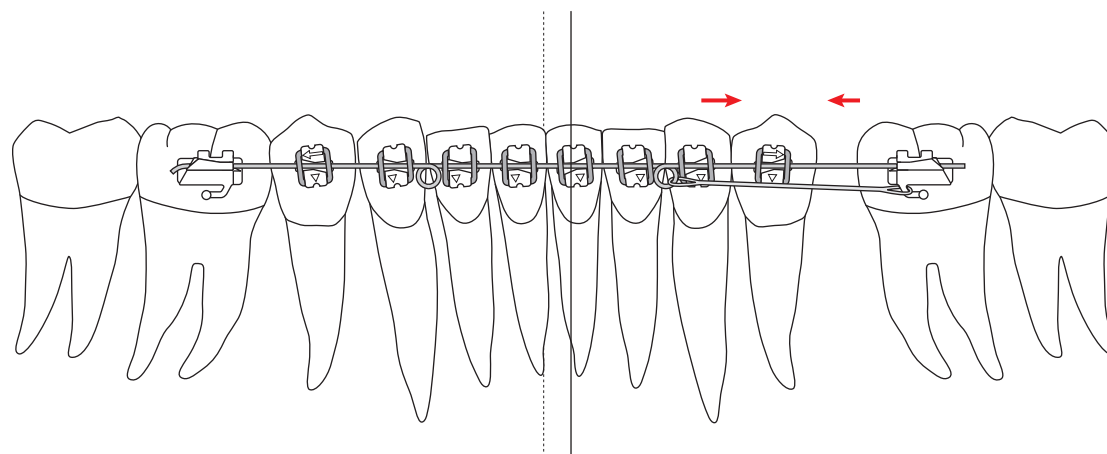


Fig. 11.8 The centreline is to the patient's right, where the extraction space is now closed. Closure of remaining space in the left quadrant will automatically correct the centreline by retraction, without the need for a brake.

into available space, so long as no contrary root resistance is generated.

This frequently works to the clinician's advantage in crowded cases, in which a centreline, if deviated, is almost invariably towards the most crowded side (Fig. 11.8). Such discrepancies may resolve without intervention, for the simple reason that space closure on the worst crowded side will be completed first, whereupon the midline will willingly drift across into the space remaining on the opposite side. However, a watchful eye is required, with a view to placing Side-Winder brakes if necessary, usually unilaterally, towards the end of Stage II.

For example, if a centreline is correct at the point where all space has closed on one side but some space remains on the other, a protective brake should be placed on the canine on the

spaced side, in order to prevent the labial segment from being pulled across (Fig. 11.9); the remaining space will now be closed by protraction. It follows from this that a centreline cannot be expected to correct if brakes are in action bilaterally (see Case 11).

It is also possible to influence centrelines from the front of the arch. Applying a Side-Winder to a mesially tipped central, or even a lateral incisor, will induce a lateral movement across the segment and influence the centreline movement towards the opposite side, particularly if supplemented by a brake to the canine behind it (Fig. 11.10).

Inevitably, centreline corrections in non-extraction cases may be more challenging, as with any technique, particularly if no arch space is available. This frequently denotes an underlying

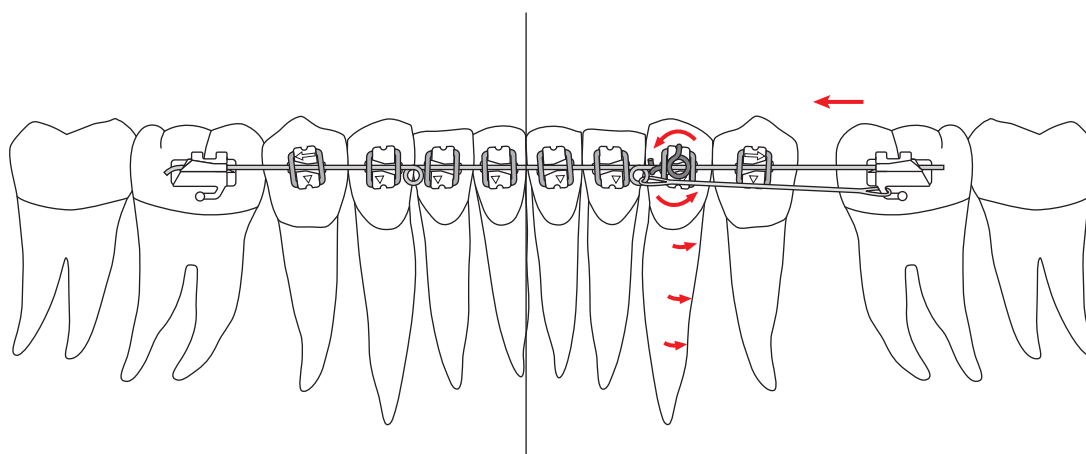


Fig. 11.9 A similar space scenario to Figure 11.8, but with a correct centreline. A defensive brake is now required to the left canine, so that the remaining unilateral space is closed by protraction, thus preserving the centreline.

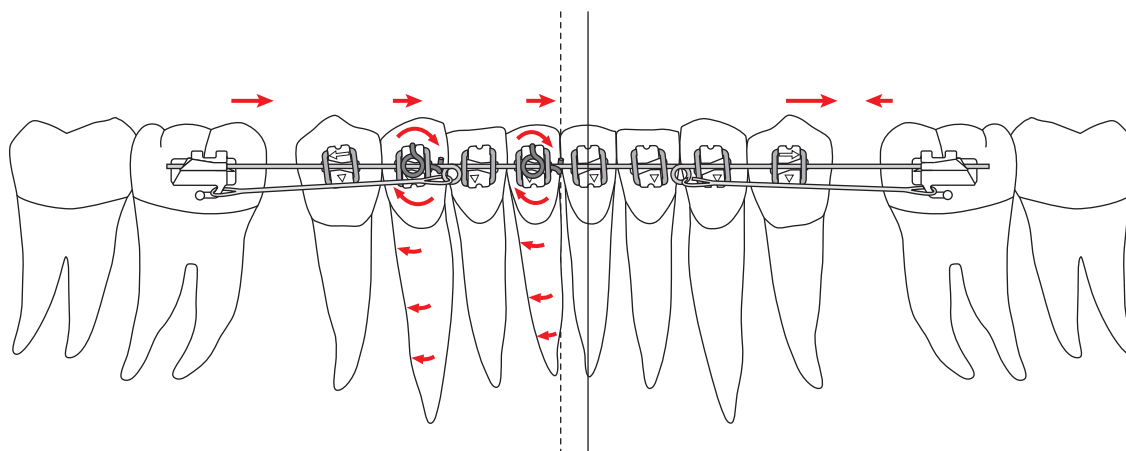


Fig. 11.10 Active correction of a centreline. Here, space exists in both quadrants, and the centreline needs correcting into the patient's left quadrant space, by retraction, whereas the space remaining in the right quadrant must be closed by protraction. The lower right canine is therefore braked. In this illustration, an additional Side-Winder is placed on the right central incisor, for distal root movement, thereby helping the centreline across.

ing skeletal component. As with straight-wire, possible options may be unilateral intermaxillary elastics, or anterior transverse elastics. In either scenario, with free-tipping brackets, Tip-Edge will prove more responsive to lighter forces during Stage II than conventional bracket systems.

Derotation of first molars

During Stage II, a limited amount of first molar rotation can be expected as a result of space closure with free-sliding mechanics. This is simply because the archwire of .020 inch diameter runs within a molar tube of .028 inch lateral dimension, so that active space closure will express this freplay as a small mesial rotation, as the molar slides along the wire. It is a mistake to try and prevent this from happening, as placement of buccal offsets and toe-ins will add friction throughout the process and need regular repositioning. It is much better, therefore, to allow the molars to slide along the wire unhindered. Only at the final visit of Stage II, when space is closed, should the molars be derotated.

This requires a simple adjustment to the archwire, placing a 1 mm buccal offset and 10 degrees of lingual toe-in opposite the interspace between the first molar and premolar (Fig. 11.11). To prevent space recurring, the distal archwire ends should be annealed and turned gingivally.

Normally, it takes only 3 weeks to derotate first molars. However, it is of paramount importance that this simple step should not be omitted. It stands to reason that while a small amount of mesial molar rotation will not interfere with the insertion of a .020 inch wire, it only takes a very small amount of mesial rotation to completely obstruct a .028 inch lateral dimension rectangular wire, which virtually fills the tube. Forgetting to derotate the molars at the end of Stage II is the commonest reason for difficulty in fitting rectangular wires at the following visit.

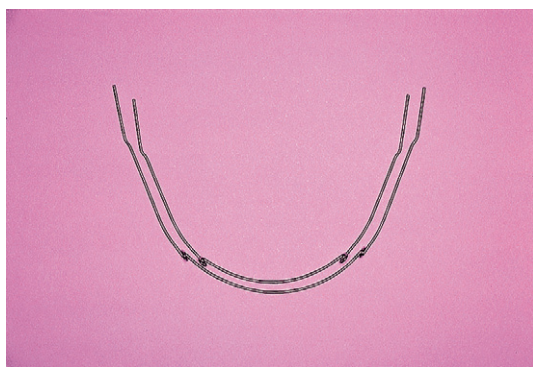


Fig. 11.11 One millimetre molar offsets and 10 degrees of toe-in for final visit of Stage II (.020 inch archwire).

Levelling of first molars

This is normally only relevant to deep bite cases treated with Class II elastics and anchor bends. Here, it is not uncommon for some distal crown tipping of the first molars to have occurred, since the roots will have been inclined mesially to boost anchorage resistance throughout Stage I. Obviously, as anchor bends are not used in the second stage, there will be a natural tendency for molar angulations to correct anyway, particularly in an extraction case, where mesial migration into the extraction space will itself tend to eliminate any distal crown tip. However, in a non-extraction case, first molars that have been worked hard during overbite and overjet reduction may need positive correction during a brief Stage II.

The vertical adjustment in the archwire can be combined with the molar derotation adjustment, opposite the premolar to molar contact point. It consists essentially of an 'anti-tip' bend of no more than 10 degrees, aimed at seating the distal molar cusps into occlusion (Fig. 11.12). In a Stage II .020 stainless wire, untipping of molars can frequently be effected in a single short visit. It is essential that the molar tubes should become horizontal and level with the brackets, as the heavier gauge rectangular archwires, shortly to follow, will not accommodate vertical angulation discrepancies.

Continuing crossbite correction

Buccal segment expansion is naturally more effective during second stage than with the lighter Stage I archwires. As already mentioned, there may be a case for using the heavier .022 inch archwire option in the maxilla, to gain more effective expansion. Either way, it is desirable to complete crossbite correction by the end of Stage II if possible since, although the rectangular wires of third stage have impressive expansion potential, particularly if torque assisted, this will usually

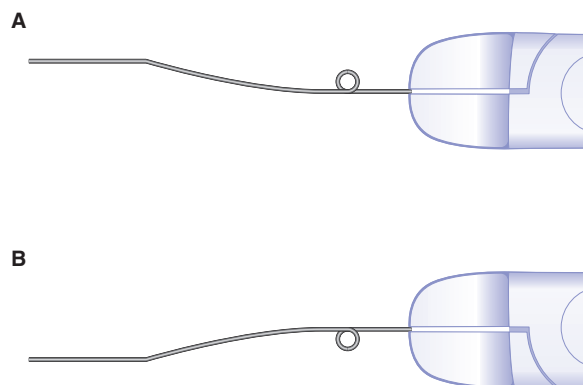


Fig. 11.12 Anti-tip bends in .020 inch wire ensure seating of the distal cusps of tipped molars at the conclusion of Stage II. These can be combined with the offset and toe-in placed at the same visit.

entail archwire removal for adjustment, at some point during Stage III.

Maintenance of Stage I corrections

This is chiefly a matter of preserving the incisor relationship, gained during Stage I, throughout the second stage. The aim is to keep enamel-to-enamel contact between the upper and lower incisors throughout. A patient can be taught to recognize this, and should be instructed to maintain this light contact by regulating the traction accordingly. With experience, the operator

can assess any likely effect Stage II may have on the interarch relationship, depending on which arch spaces are to be closed and whether or not brakes are in use. Mandibular growth is another influencing factor. Therefore, if Class II elastics are the anchorage source, the patient will need to wear these as much as is needed to maintain the incisor relationship. In practice, nights only wear, or perhaps evenings and nights, is the likely expectation; it is unusual for full-time elastic wear to be necessary once beyond Stage I. Likewise, in the rare instance of a patient being a headgear wearer, this will require to be worn for only as many nights a week as proves necessary to keep incisor contact.

Case 5

A mild Class II division 1 malocclusion with increased overbite and lower arch crowding with centreline shift treated with the Plus bracket

Treated by Dr Christopher Kesling



Pre-treatment					
L1-APo	mm	+0.5	SNB	°	81.5
Wits	mm	+1.5	ANB	°	3.5
SN-MP	°	30.0	U1-SN	°	98.5
SNA	°	85.0	U1-OP	°	68.0



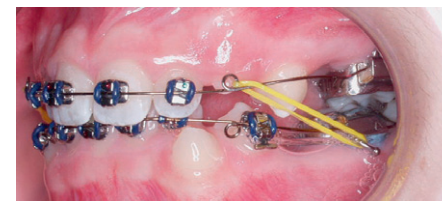
1

At 12 years 5 months, the facial appearance, as opposed to the dental appearance, is good. Skeletally Class I, with a Wits of +1.5 mm, the lips appear in good balance with the lower incisors fractionally in front of the A-Po line.



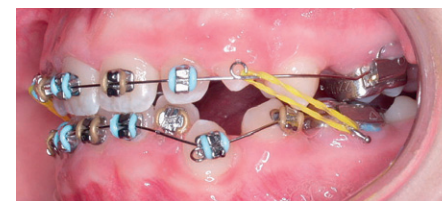
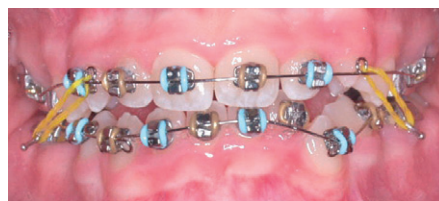
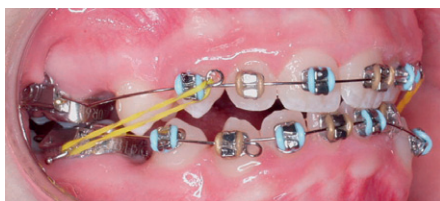
2

There is a small increase in overjet, together with an increased overbite. While the erupting upper canines are only marginally crowded, there is major crowding of the lower fronts, with the left canine almost blocked out buccally and a big shift of lower centreline towards that side. Space evaluation suggests that attempting the case with non-extraction will cause the anterior segments to become too protrusive. However, any extraction approach must not be allowed to compromise the facial profile. Four second premolar extractions were therefore preferred to first premolar extractions.



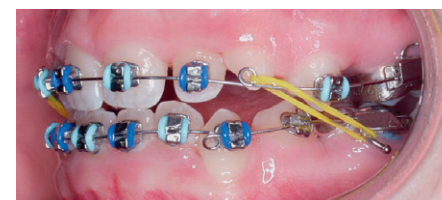
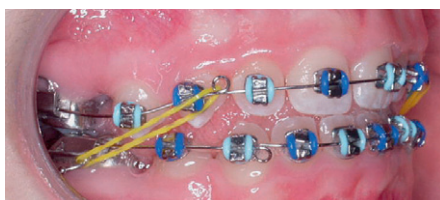
3

Typically, Stage I uses high tensile .016 inch stainless archwires. Anchor bends will reduce the overbite in round molar tubes. Normally the premolars would be left unbonded, but since the erupting lower left canine cannot yet be bonded and space is needed for it, the first premolar is being retracted (there is plenty of available anchorage). Note that the retracting elastomeric is applied to a Power Pin, rather than directly to the bracket. The upper canines are not yet ready for inclusion.



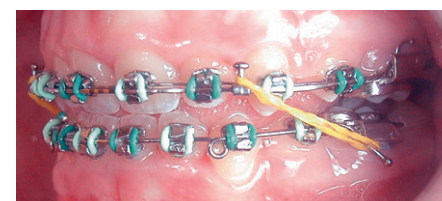
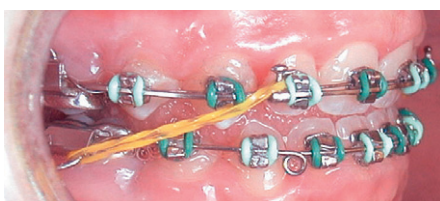
4

Within 3 months, there is plenty of space for the lower canine. It is bonded and engaged to bring it lingually, tying out the lateral incisor with 'Zing String'. The canine will ease distally without active retraction.



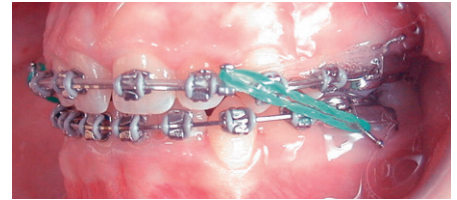
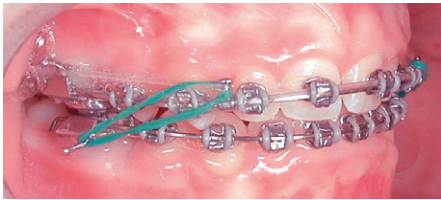
5

All premolars can now be aligned to the rectangular molar tubes. Bite sweeps have replaced the anchor bends to maintain the overbite reduction.



6

Following bonding of the upper left canine and then a .022 inch round upper arch (not shown), the upper has progressed to a Stage III .0215 × .028 inch rectangular archwire. A .014 inch nickel-titanium deep tunnel archwire is providing torque and tip correction. See how the distal ends of the uprighting wire cross the main archwire occlusally before seating in the round molar tubes. This ensures maximum uprighting to the premolars. It is worth noting also how the lower centreline has corrected naturally, in this case without recourse to traction or braking. Meanwhile, the lower arch is in an interim Stage II .022 inch round wire.



7

Nearly there! Both arches are in full rectangular wires with a .014 inch nickel–titanium in the upper deep tunnels, .012 inch in the lowers. Upper E-links (E-8 between the canines, E-5 down the buccal segments) are condensing small spaces.



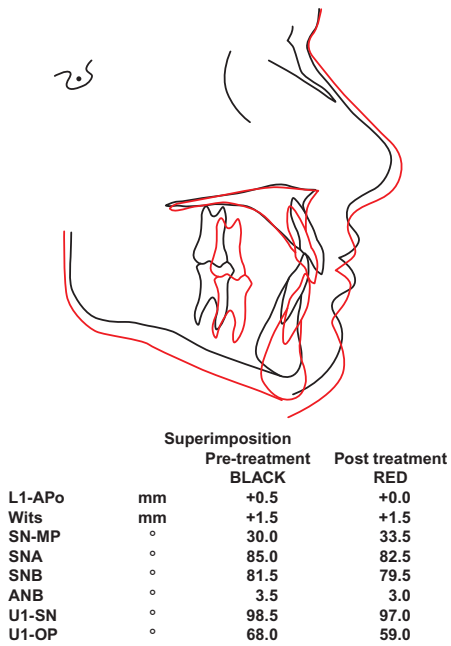
8

Active treatment has taken 18 months. The overbite has settled in nicely.



9

Excellent facial harmony and lip balance has been preserved, now matched by the dental aesthetics.



10

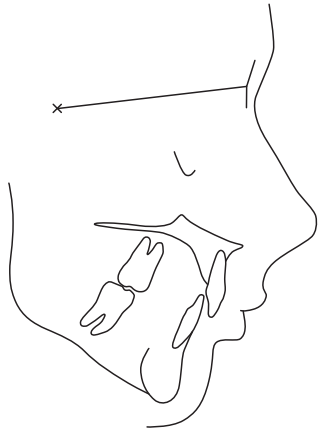
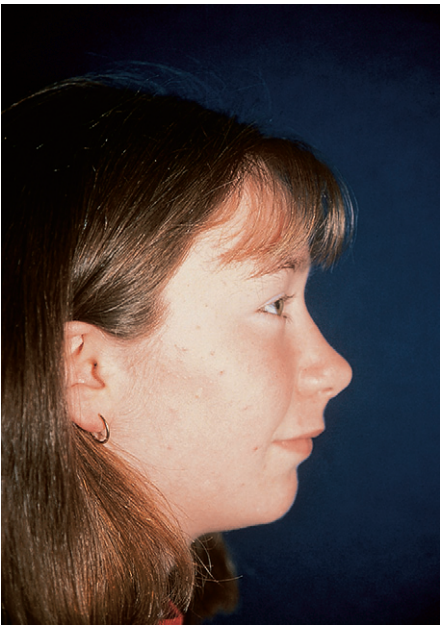
The lower incisors have maintained their angulation in a favourably growing mandible, with good occlusal plane stability and a greatly improved smile.

Treatment

Treatment time = 1 year 6 months.
Routine adjustments = 10.
Main archwires used = 6 (3 upper, 3 lower).
Retention = Perfector, upper removable retainer,
lower 3 × 3.

Case 6

A severely crowded Class II division 2 malocclusion on a marked skeletal II base treated with the Rx-1 bracket


Pre-treatment			
SKELETAL		TEETH	
SNA	° 76.5	Overjet	mm 5.0
SNB	° 70.0	Overbite	mm 6.0
ANB	° 6.5	UI/MxP	° 88.5
SN/MxP	° 15.0	LI/MnP	° 86.0
MxP/MnP	° 25.5	LI-APo	mm -3.0
LAFH/TAFH	% 51.0		

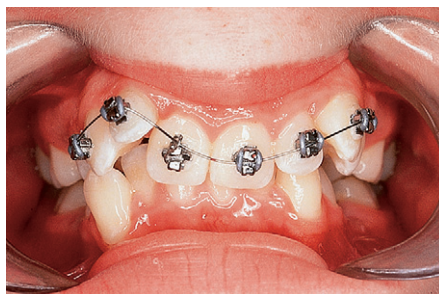
1

At 14 years 4 months, a challenging case! An ANB angle of 6.5 degrees confirms an appreciable Class II skeletal discrepancy, with a reduction in lower face height (51%) and maxillary-mandibular planes angle (25.5 degrees). The upper central incisors are severely retroclined and the lower incisors lie 3 mm behind A-Po.



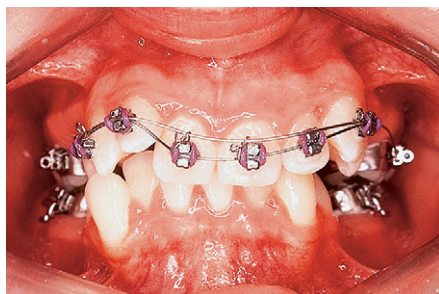
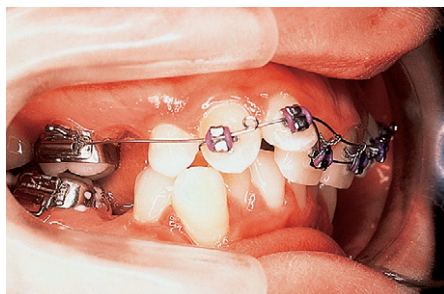
2

The overbite is increased and complete and both arches are severely crowded anteriorly. The lower right canine has a particularly adverse inclination. The buccal segment occlusion is a full unit Class II on the right, and is little better on the left. This degree of crowding necessitates premolar extractions. In consideration of the retrusive profile, four second premolars were preferred to first premolar extractions.



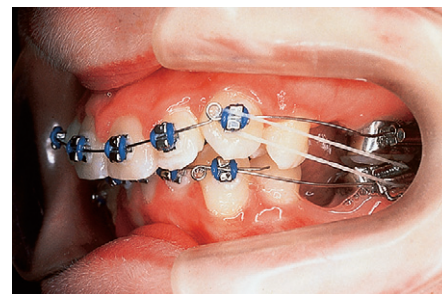
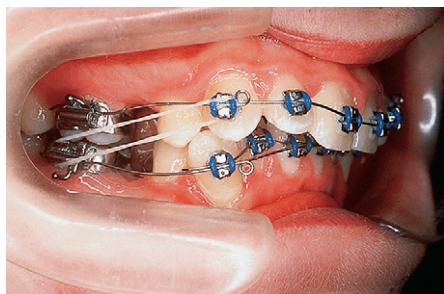
3

It is good practice to procline the upper incisors away from the lowers in the initial treatment visit. This avoids the risk of bite damage to the lower incisor brackets, and also prevents the extrusion of opposed first molars if temporarily out of occlusion due to anterior bracket interference. Another reason for proclining upper incisors prior to Stage I is that intrusion of a normally angulated or proclined upper incisor will result in a favourable palatal root path, whereas intruding a retroclined incisor may drive the apex further labially, adding to the amount of torque that will be required later. In this case, the incisor displacements are too extreme to allow comfortable use of a stainless archwire. Consequently, preliminary alignment and proclination of the upper anteriors involves a sectional .012 inch nickel-titanium wire. To avoid loss of extraction space in this maximum discrepancy case, rapid progression to stainless archwires with anchor bends must be planned.



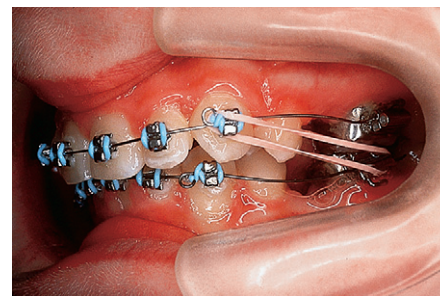
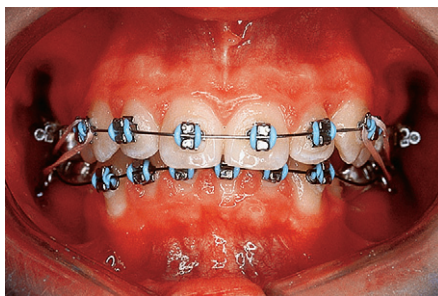
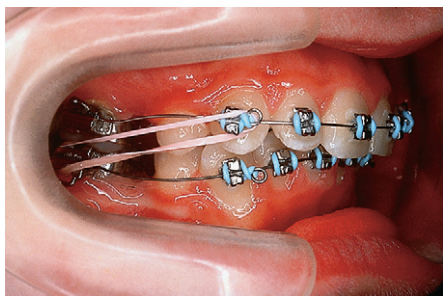
4

Three weeks later, it is possible to supplement the sectional with a .016 inch high tensile stainless archwire, loose tied into the upper central incisors. Light tip-back bends prevent mesial drifting of the upper molars.



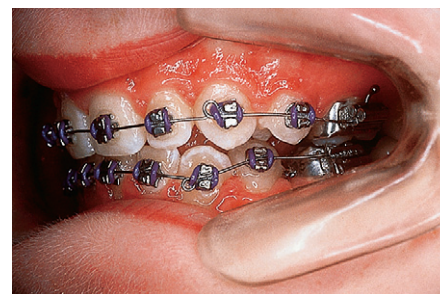
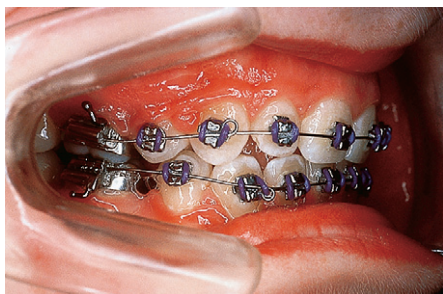
5

At the following visit Stage I begins. The upper arch can be fully engaged, with cuspid circles rolled distally, and a matching lower arch is fitted with a .012 inch nickel-titanium underarch to align the instanding incisors. Strong anchor bends are employed to all round first molar tubes, in combination with 50 gram Class II elastics. In common with previous increased overbite cases, the premolars are omitted until overbite reduction is complete.



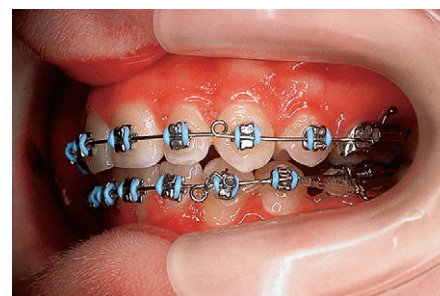
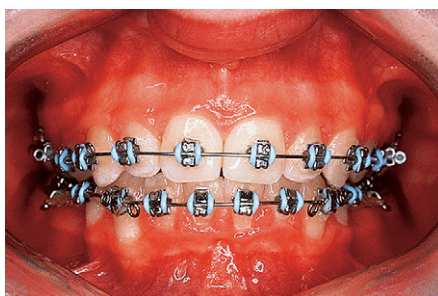
6

Three months later: the lower anteriors are aligned, so the underarch can be discarded. Reduction of overbite and overjet are ongoing.



7

Incisor contact has been achieved above the lower incisor brackets. The premolars are therefore bonded, for alignment to the rectangular molar tubes, using the existing archwires but with bite sweeps replacing the anchor bends. As with previous cases, the round molar tubes will not be used again and night time elastic wear will normally be enough to retain the new incisor relationship throughout remaining treatment.



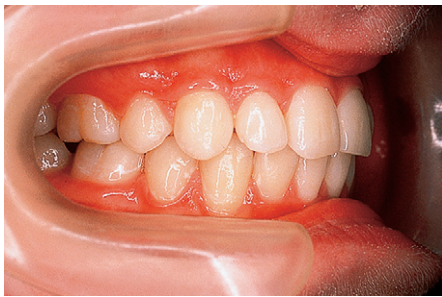
8

Only lower extraction spaces remain. With swept .020 inch Stage II stainless archwires, Side-Winder brakes are added to both lower canines. The E-5 elastomeric intramaxillary links will therefore protract the lower molars towards a Class I relationship.



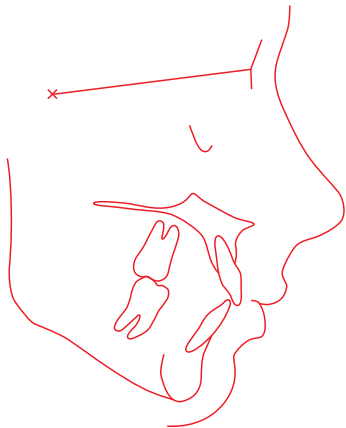
9

Stage III .0215 × .028 inch pretorqued archwires are fitted. The lower pretorqued archwire has been swept to a zero torque setting across the incisor segment, while the upper is slightly 'overswept' past the zero torque position, to produce some additional torque and overbite control. Elastic wear will normally be nights only, to maintain the interarch fit, although this may vary between different individuals according to mandibular growth. Today, with Plus, this third stage would be spring-free!



10

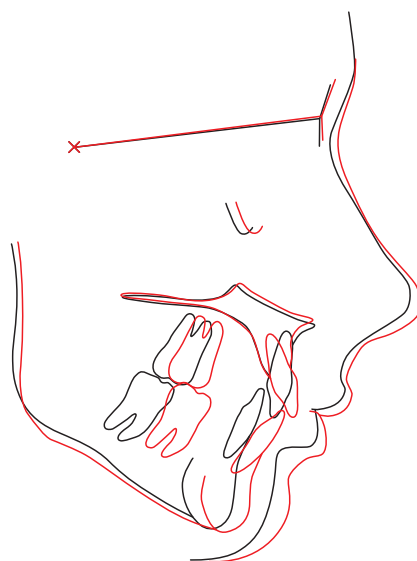
Torque and tip have been fully expressed for all bracketed teeth, individually, by the Side-Winders.



SKELETAL		Post treatment		TEETH	
SNA	°	75.5		Overjet	mm 3.0
SNB	°	72.0		Overbite	mm 1.0
ANB	°	3.5		UI/MxP	° 114.0
SN/MxP	°	14.5		LI/MnP	° 101.0
MxP/MnP	°	22.0		LI-APo	mm 2.5
LAFH/TAfH	%	52.0			

11

The interincisal angle has been overcorrected with a much improved facial profile.



Superimposition
Sella-Nasion at Sella



12

Mandibular growth has been good, with no opening of the mandibular angle. The skeletal pattern has therefore improved (ANB reduced by 3 degrees) and there is also an improvement in gummy smile.

Treatment

Treatment time = 1 year 11 months.

Routine adjustments = 16.

Archwires used = 6 (3 upper, 3 lower).

Retention = upper and lower Hawleys, nights only.

CHAPTER 12

Setting up Stage II

Archwire preparation	109
Fitting the arches	110
Adding brakes	111

Setting up Stage II

Stage II is very easy to set up and maintain, and has much in common with straight-wire practice.

Archwire preparation

Preformed arches are available and represent a considerable time saving. Made from .020 (or .022) inch Bow-Flex high tensile stainless steel, selection is similar to that described for Stage I, using the intraoral measure to determine the desired distance between the cuspid circles. However, in Stage II, the cuspid circles require to be somewhat further mesially from the canine brackets (Fig. 12.1). This is so as not to obstruct the possible placement of brakes on the canines, when the arms of the Side-Winders will point mesially. Mid-way between the canine and lateral incisor brackets is therefore the best place for the cuspid circles. The position of these circles will not require any subsequent adjustment.

Archform will be essentially similar to Stage I, with the anterior curvature extending distal to the canines (Fig. 12.2). However, there will be no anchor bends, and there is no need to incorporate any expansion unless, of course, a crossbite is

being corrected. A straight posterior leg is preferred down the buccal segments, which avoids the complex double curvature when combining a vertical bite sweep with a buccal convexity.

The archwire can readily be tailored for arch width and length, leaving 2 mm projecting distal to each molar tube. These ends should be annealed.

Whether or not vertical bite sweeps will be required will depend on the initial degree of overbite. If the overbite was

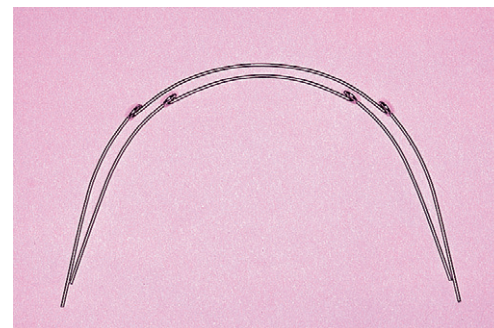
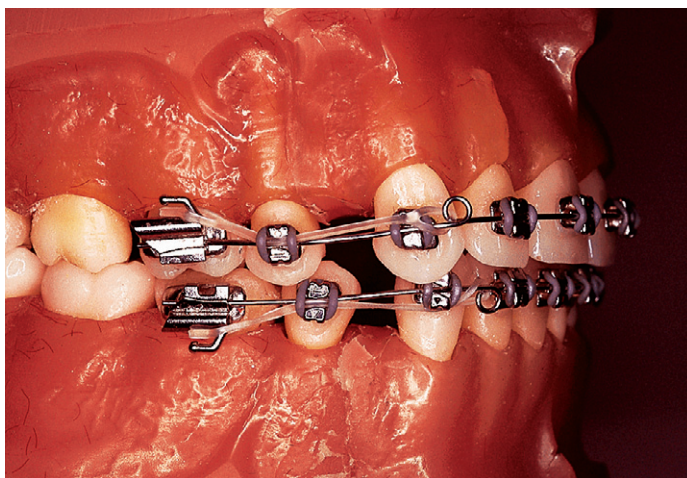
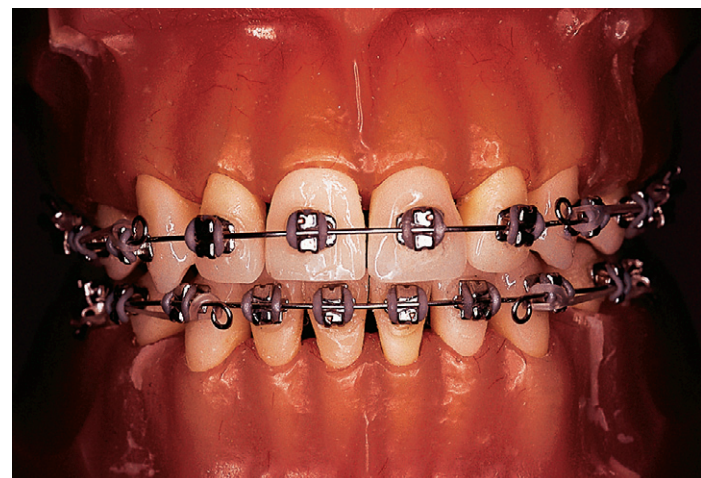


Fig. 12.2 Stage II archform (.020 inch archwires).



A

Fig. 12.1 Stage II with .020 inch archwires.



B

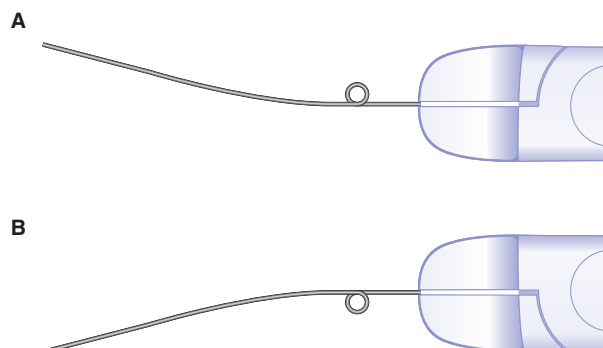


Fig. 12.3 Vertical 'bite sweeps' will be needed to maintain a previously reduced overbite.

originally decreased, the archwires can be fitted flat, whereas a case that started with an increased overbite will need bite sweeps, in order to retain the overbite reduction gained during the first stage. These will consist of a reverse curve of Spee in the lower arch and an increased curve of Spee, or 'rocking horse' curve, in the upper (Fig. 12.3).

Wiping in the vertical sweeps is best done with thumb and finger while holding the archwire immediately distal to the circle in a light wire plier. A mistake commonly made is to wipe in the sweeps before cutting the distal arch ends to length, in which case the operator has less idea of precisely what length of sweep is relevant to the mouth. This also introduces the danger of extending the sweeps into the molar tubes, which will tend to perpetuate distal crown tip of the molars. Vertical bite curvatures work best when confined to the canine and premolar regions.

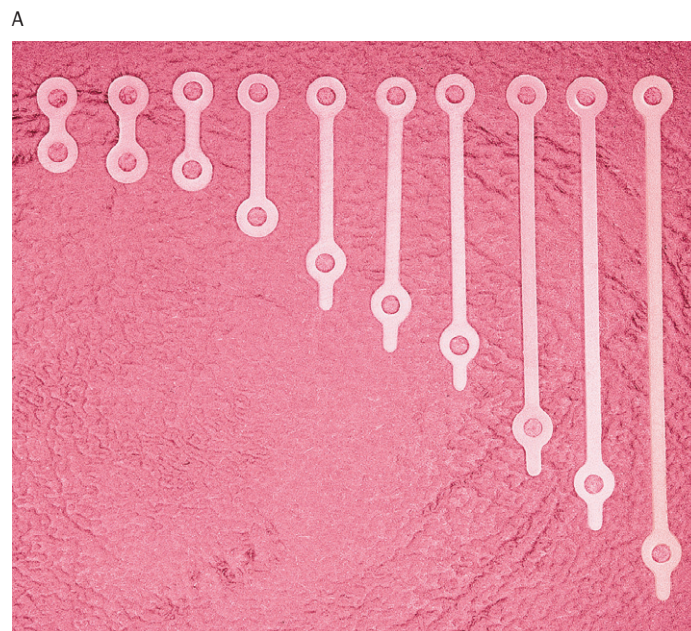
As for the angle of sweep, this is readily estimated on insertion. A millimetre or two of active intrusion in the archwire will generally be sufficient to retain a reduced overbite, as measured at the midline.

Fitting the arches

Rectangular molar tubes are invariably used throughout Stage II. All six upper and lower anterior brackets are ligated with elastomerics in the usual way.

Space closure is carried out using elastomeric E-Links. These are preferred to elastomeric chain, the force of which can only be crudely adjusted according to the number of links chosen. E-Links come in graded lengths (Fig. 12.4) and their tension is dissipated along their length rather than confining the force to the short span across the space. Clinical experience suggests a respectable working life of up to 3 months in the mouth, although they will normally be replaced at 6-week intervals.

Each E-Link runs from the buccal hook on the first molar to the cuspid circle. In a premolar extraction case, an E6 will most often be the appropriate size, sometimes progressing to an E5



B

Fig. 12.4 E-Links come in 10 available sizes.

when the space has almost closed. It will be noted that in sizes E5 and above, a small tail is provided, but this is not relevant to Stage II. (This tail enables the E-Link to be used as a lasso, by feeding the tail through the circle at the opposite end and pulling tight. This feature may occasionally prove useful for retrieving impacted teeth early in treatment.) Either the tail can be amputated with ligature cutters, or placed at the distal end of the link, where it will be concealed behind the molar hook and will not worry the patient.

Because the mesial end of the E-Link is attached to the cuspid circle, it is not necessary to ligate the canine brackets to the cuspid circles during Stage II (or at any future time in treatment). The reason is that the E-Links exert an overall space-condensing force from the cuspid circles, which will also prevent the archwire sliding from side to side.

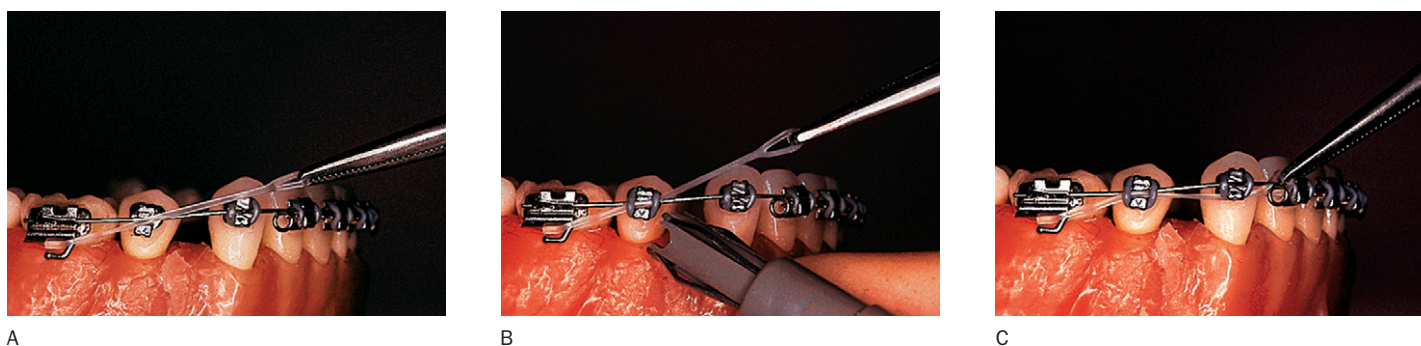


Fig. 12.5 Placement of E-Links. (A) The operator engages the tagged end around the molar hook and stretches the E-Link across the premolar bracket. (B) The assistant holds the E-Link in position while the operator ligatures the premolar. (C) The operator engages the forward end around the cuspid circle.

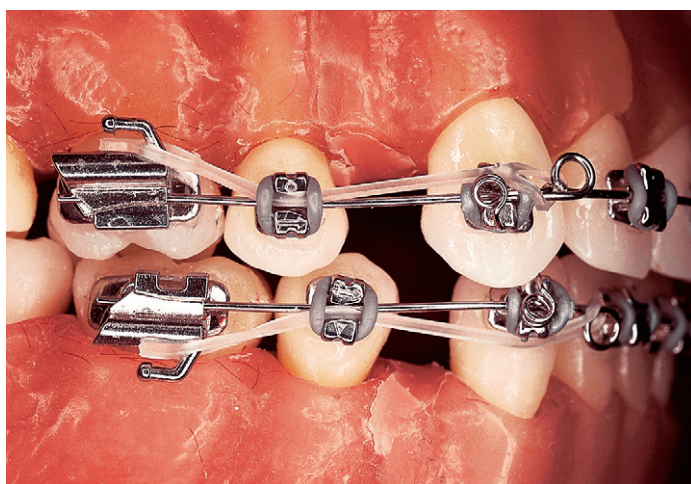


Fig. 12.6 Brakes placed on upper and lower canines for a 'protractive' Stage II.

A long strand of elastomeric running parallel to the archwire may constitute a 'fiddle factor' for the patient, which is why the author prefers to route the E-Link beneath the retaining module on the premolar. This makes it less conspicuous and therefore less tempting! Friction does not appear to be increased by so doing and loss of an E-Link between visits is a rarity. The sequence of placement is illustrated in Figure 12.5.

The annealed arch ends should be bent lingually, distal to the molar tubes, to preserve patient comfort as the ends grow longer during space closure. However, if a space has already closed, this should be retained by cinching the arch end gently to the gingival. This is preferable to leaving an E-Link in place to hold a space closed, as this risks over closure of the spaces, provoking overlapping contacts. Not only can this encourage relapse of previous rotations but, as will be stressed in Stage III, teeth require additional mesio-distal space when being uprighted. Tight contacts will 'choke' the action of the uprighting during the third stage, and is one of the major reasons for inadequate expression of final torque and tip angles in the final result.

Adding brakes

If a quadrant is to be braked, a Side-Winder auxiliary spring will be required, usually to the canine, but possibly to a first premolar, or even to both. The spring should be inserted down the vertical slot from the occlusal before placing the elastomeric ligature. The arm of each spring, when used as a brake, should point mesially (Fig. 12.6). Activation of the spring should not normally exceed 45 degrees for braking purposes.

CHAPTER 13

Stage II checks

Case 7 A high mandibular angle case with marked upper and lower anterior crowding treated with the Plus bracket	116
Case 8 A Class III case with a complex reverse overjet treated with the Rx-1 bracket	120

Stage II checks

The routine adjustment interval in Stage II is 6 weeks, but can often be extended to 8 weeks. It is not normally necessary to remove the archwires, except at or very near the end of the stage, when offsets and toe-ins will be needed to derotate the first molars.

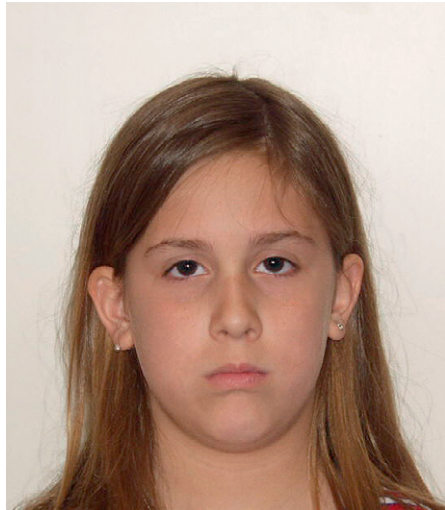
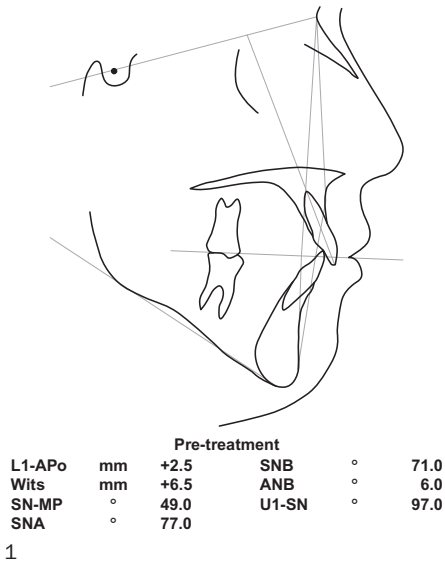
At each adjustment visit, the following checks will be necessary:

- **Observe space closure.** This can either be measured direct, or gauged by the amount of excess archwire protruding from the distal of the molar tubes. Where further space remains to be closed, the elastomeric E-Links should be replaced. *Obstruction to space closure is rare, but can be caused by premature placement of offsets and toe-ins to the first molars.*
- **The distal archwire ends.** These should be trimmed back to 2 mm of distal projection and turned slightly to the lingual, for the comfort of the patient. If all space has closed in a particular quadrant, the respective distal archwire end should be annealed and turned gingivally, to prevent the space reopening.
- **Check molar widths.** Normally, these will not require adjustment, unless a crossbite is being corrected. However, as with any appliance, second molars in a first molar extraction case will need particular vigilance as they come forwards.
- **Labial segment position and inclination.** This may require the addition or removal of brakes, according to whether remaining space closure is required by retraction of the incisors, or by protraction of the molars. *Excessive retroclination of upper incisors should be avoided (by placement of brakes on upper canines), as this may encourage apical resorption.*
- **Attention to centrelines.** Except in the case of big midline discrepancies, remedial action will not be required until towards the end of the second stage. At that time, the application of selective brakes should be considered, as described in Chapter 11, usually unilaterally. This may be to induce active centreline correction (see Fig. 11.10) or to defend against an unwanted late shift (see Fig. 11.9) when space remains on one side but not on the other. *Failure to obtain coincident midlines by the end of Stage II will inevitably result in an occlusal discrepancy, which will be less easy to correct in Stage III.*
- **Derotation of first molars.** Only relevant at the end of Stage II, this is essential once the space has closed. A 1 mm buccal offset and 10 degrees of lingual toe-in should be added to the archwire at the molar–premolar interspace, as outlined in Chapter 11. *Failure to do this will make it difficult or impossible to enter the molar tubes with rectangular archwires at the next visit.*
- **‘Un-tip’ the first molars.** Of likely relevance to deep bite non-extraction cases, where Begg-derived mechanics have been used during Stage I, anti-tip bends may be required to seat the disto-buccal cusps, as described in Chapter 11. *Again, it will be difficult or impossible to feed a rectangular archwire into a distally tipped molar at the Stage III visit.*
- **Avoid overcompression.** At the end of space closure, tight or overlapping contacts should be relieved, by relaxing the gingival cinchbacks at the distal arch ends. *Contact point pressure will significantly retard or halt correction of torque and tip in the following stage.*
- **Check the interarch relationship.** Is the patient observing and maintaining their incisor relationship as instructed? Are the intermaxillary elastics being worn sufficiently to maintain Stage I corrections?

Case 7

A high mandibular angle case with marked upper and lower anterior crowding treated with the Plus bracket

Treated by Dr Christopher Kesling

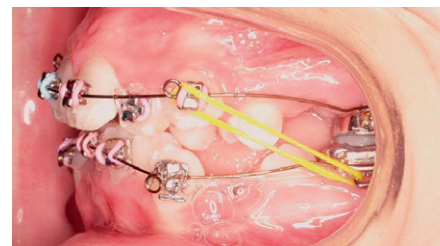
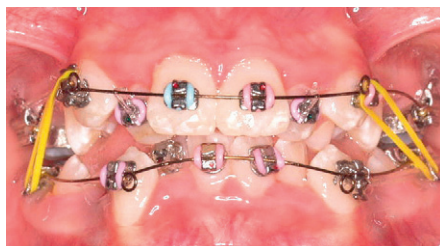
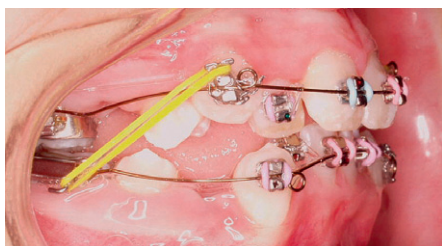


At 10 years 9 months, a 'high angle' case. The clockwise growth pattern of the mandible gives a slightly postnormal appearance (ANB = 6, Wits +6.5 mm).



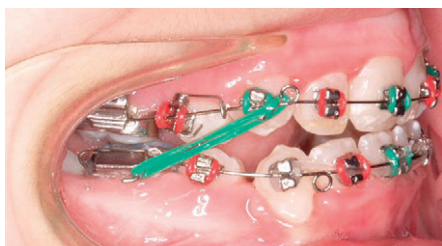
2

All four canines are badly crowded, with instanding upper lateral incisors and rotations of the lower left incisors. The need for premolar extractions is obvious. The choice of maxillary second and mandibular first premolars was based on relative crown sizes, the upper first premolars being larger than the seconds and vice-versa in the lower arch. Such flexibility in treatment planning becomes possible with a light anchorage appliance, in this case resulting in retaining the biggest and best shaped units.



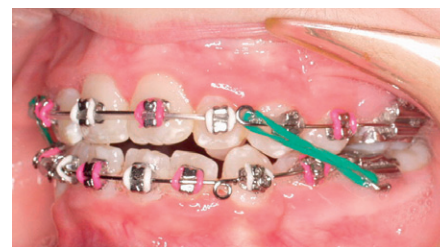
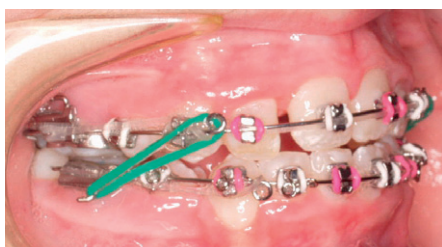
3

The occlusion appears to be slightly propped open by the placement of the appliance. Since there was some overbite, the premolars have been excluded initially. The archwires are .016 inch high tensile stainless with gentle anchor bends in this high angle case, using the round molar tubes. Dr Kesling has opted to tie out the instanding units with elastic thread instead of using an underarch, and the rotated lower left lateral is unattached. A light E-link is therefore retracting the lower left canine to make room for the lateral. Sufficient anchorage should be available to allow this. Wire ligature ties are only used briefly at the start, to ensure archwire security.



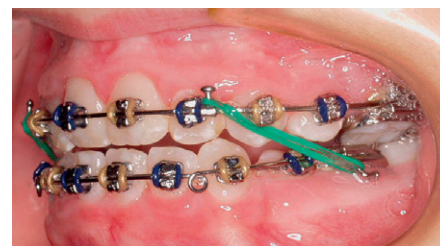
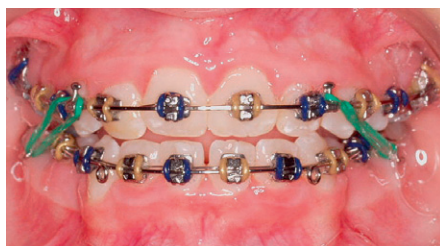
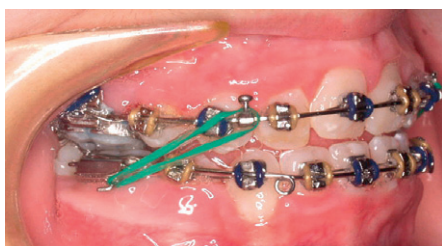
4

Four months into treatment, Stage I is complete except for the lower midline space and alignment of the lower left lateral. It is time to pick up the premolars and level these to the rectangular molar tubes, continuing the existing Stage I archwires. Rotating springs will align the premolars. Simultaneously, an E-link is gathering the lower midline space to the right, while elastomeric thread rotates the errant lateral incisor towards arch line.



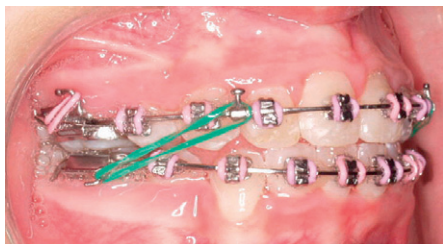
5

Stage II is closing right sided spaces along .022 inch high tensile stainless archwires. E-links are used along both right buccal segments (size 6). An E-9 link is closing the upper anterior space. Side-Winder brakes are placed on both lower canines, to hold the labial segment forward, also on the lower right lateral incisor to defend the centreline.



6

After 10 months of treatment, upper torquing begins, activated by a .014 inch nickel-titanium uprighting arch in the deep tunnels, against a rectangular stainless .0215 × .028 inch main archwire. The lower remains in .022 inch round wire, but a .014 inch nickel-titanium uprighting arch is at work in the tunnels, in anticipation of a rectangular main archwire at the next visit.



7

Both arches are now in a full rectangular Stage III setup. Because of the premolar extraction pattern, the lower deep tunnel wire terminates in the round molar tubes, whereas the upper is routed over the occlusal surface of the main archwire (for maximum uprighting of the second premolars) its distal ends secured outside the buccal tubes, beneath the elastomerics. In cases treated subsequently, Dr Kesling threads the ends over the main arch and into the round tubes, as illustrated in Fig 17.10.



8

Treatment concludes after 17 months, 7 of which involved torquing.



9

Profile and full face aesthetics have clearly improved. Skeletally, she now looks truly Class I.



Superimposition			
		Pre-treatment	Post treatment
		BLACK	RED
L1-APo	mm	+2.5	+2.0
Wits	mm	+6.5	+3.5
SN-MP	°	49.0	46.0
SNA	°	77.0	77.0
SNB	°	71.0	72.0
ANB	°	6.0	5.0
U1-SN	°	97.0	103.0



10

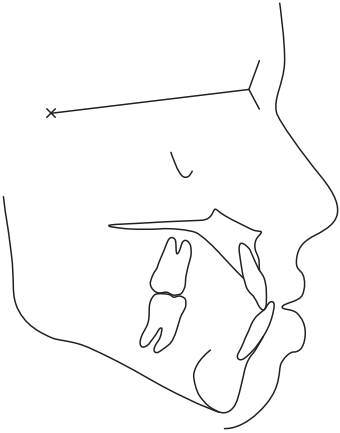
The high mandibular angle might have opened further with extrusive mechanics. However, gentle anchor bends, used only briefly, combined with very light Class II elastics, have allowed a favourable vector of mandibular growth.

Treatment

- Treatment time = 1 year 5 months.
- Routine adjustments = 9.
- Main archwires used = 6 (3 upper, 3 lower).
- Retention = Perfector, upper removable retainer, lower 3 × 3.

Case 8

A Class III case with a complex reverse overjet treated with the Rx-1 bracket







Pre-treatment			
SKELETAL		TEETH	
SNA	° 85.0	Overjet	mm -3.0
SNB	° 83.0	Overbite	mm 3.0
ANB	° 2.0	UI/MxP	° 110.5
SN/MxP	° 9.0	LI/MnP	° 96.5
MxP/MnP	° 23.0	LI-APo	mm 7.5
LAFH/TAFH	% 56.0		

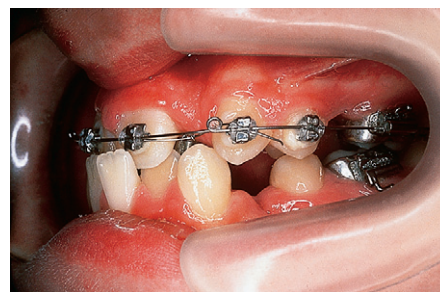
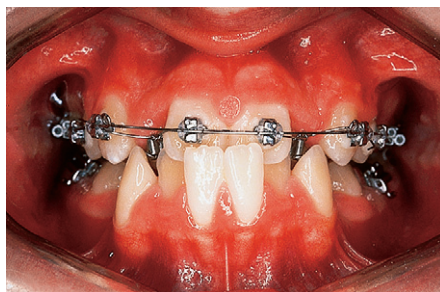
1

A skeletal Class III case at 13 years 10 months, with a slight reduction in maxillary–mandibular planes angle (23 degrees). The crowded lower central incisors are procumbent, suggesting that some retraction should be possible to enable a positive overjet correction. Since overbite reduction will not be required, round molar tubes will not be necessary and the premolars will be included from the beginning.



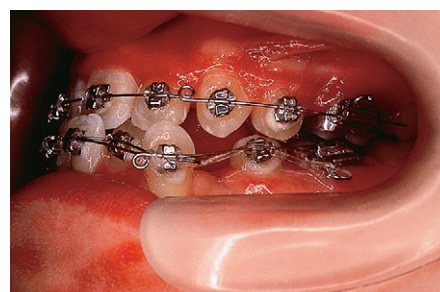
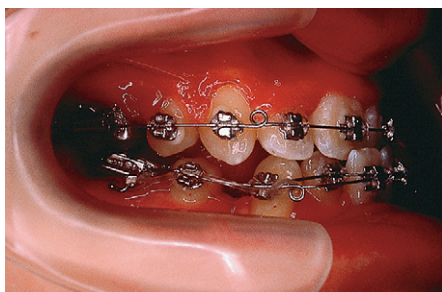
2

Described by the parent as ‘four rows of teeth’, this is a bizarre pattern of incisor crowding and reverse overjet interlock, surprisingly without forward mandibular displacement. All four lateral incisors are bodily displaced lingually, the uppers grossly. Since the lower central incisors are 8 mm in front of A–Po and both anterior segments are considerably crowded, four premolar extractions will be indicated. These will be lower first premolars, to accommodate the crowding and lingual repositioning, but upper first premolars are retained to help support a proclined upper incisor segment in positive overjet, second premolar extractions being preferred.



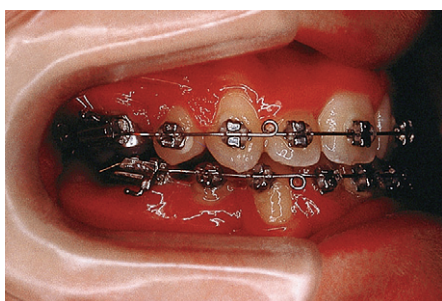
3

Anterior bite interference prevents bracketing of the lower lateral incisors initially. The reverse overjet is therefore tackled in two stages, upper arch first. A .016 inch high tensile stainless archwire is fitted flat. The upper lateral incisors carry temporary brackets, into which a .012 inch nickel-titanium underarch is loosely tied.



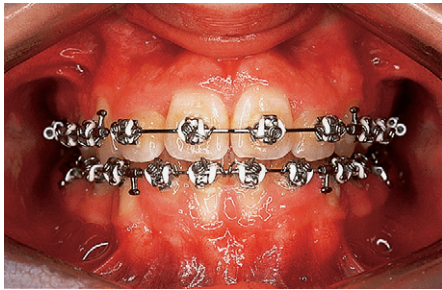
4

Three months later, the upper laterals are in positive overjet and can be correctly bracketed. The underarch is discarded. Much of the upper extraction space has closed by distal drifting of the canines and premolars. Lower arch treatment begins with a flat .016 inch high tensile stainless archwire with a .014 inch nickel-titanium underarch to align the instanding lower lateral incisors. Intramaxillary traction with E-5 elastomerics will correct the reverse overjet on the lower central incisors.



5

The objectives of Stage I are essentially the same in Class III cases as for other malocclusion types and have been achieved in 8 months. Since all extraction space has been taken up, the interim .020 inch stainless Stage II archwires have only to derotate the first molars, with a buccal offset and toe-in, mesial to each molar tube.



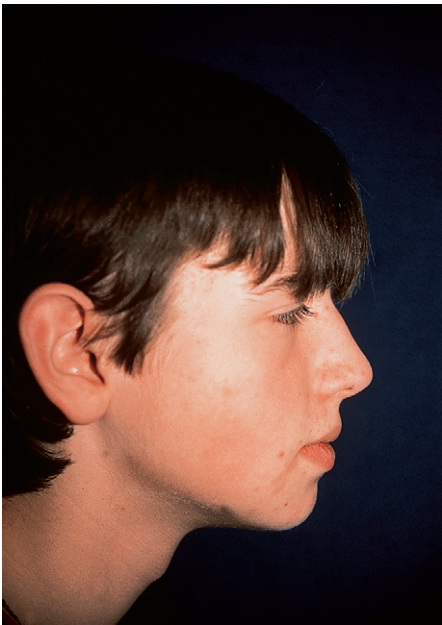
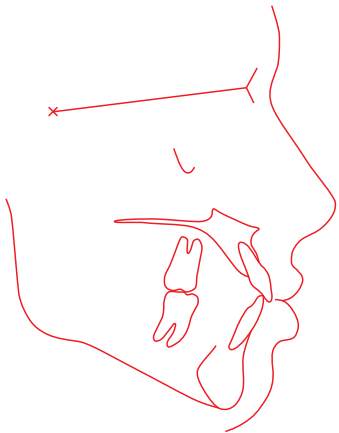
6

.0215 × .028 inch stainless archwires are fitted flat. In view of the Class III skeletal pattern, which may deteriorate with remaining growth, skeletal compensation is advisable in the anterior segments (mesial to the hooks). As described in Chapter 16, 8 degrees of retroclination can be obtained from a mandibular pretorqued archwire when fitted flat, without a bite sweep. Proclination of the upper incisors can be achieved by fitting a 5 degree pretorqued maxillary arch inverted, or a suitably expanded 8 degree mandibular archwire. In this case, the latter is appropriate, with slight manual enhancement, producing approximately 10 degrees of proclination. In both archwires, the posterior segments (distal to the hooks) are returned to zero torque. Since this case predated the Plus bracket, all uprighting is carried out with Side-Winders.



7

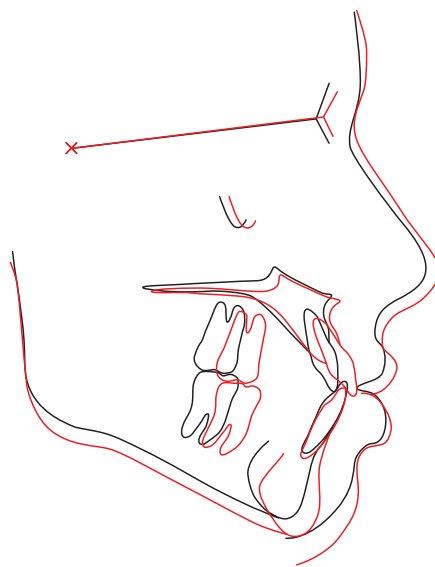
After 9 months in Stage III, all bracketed teeth have been individually torqued and tipped to the prescription described above. Class III intermaxillary elastics were confined to nights only use during Stage III. Note that the alignment of all four lateral incisor apices has been achieved without individualized archwire adjustment, and without inversion of the upper brackets. This is because each Tip-Edge archwire slot is closed into full approximation with the archwire, with no remaining free play.



Post treatment				
SKELETAL		TEETH		
SNA	°	85.0	Overjet	2.5
SNB	°	82.0	Overbite	mm 2.0
ANB	°	2.5	UI/MxP	° 119.5
SN/MxP	°	10.0	LI/MnP	° 98.0
MxP/MnP	°	21.5	LI-APo	mm 5.5
LAFH/TA FH	%	56.5		

8

There is some improvement in lower face profile, despite worsening prognathism, due to the setting back of the lower anterior segment.



Superimposition
Sella-Nasion at Sella



9

Taking account of mandibular growth, the lower incisors have been moved bodily lingually.

Treatment

Treatment time = 1 year 8 months.
Routine adjustments = 10.
Archwires used = 6 (3 upper, 3 lower).
Retention = upper and lower Hawleys, nights only.

Stage III: how it works

Objectives	127
Limitations of conventional torquing	127
How does Tip-Edge torque?	128
Points to note	130
In summary	130
Anchorage considerations	130

Stage III: how it works

Objectives

1. Correction of torque and tip angles for each tooth individually.
2. Attainment of optimum facial profile compatible with stability.
3. Maintenance of Class I occlusion.
4. Final detailing.

In essence, Stage III produces the perfect finish, that 'celebrity smile' that we can confidently promise to our patients!

To conventional orthodontic thinking, it may be difficult to conceive that such a finish will be readily possible, either mechanically or physiologically, from an appliance that accommodates angles of torque and tip discrepancy that lie far outside the range of recovery normally possible with straight-wire brackets. Perhaps even more difficult to imagine is that such a recovery, in the hands of an experienced operator, is largely maintenance free, accomplished by a single upper and lower rectangular archwire only, frequently requiring no removal for adjustment.

Indeed, having exploited all the advantages of free tipping early in treatment, it is imperative that Tip-Edge should have a reliable uprighting and torquing mechanism, well beyond the capability of conventional brackets. Without this, it would be unable to match the finishing precision for which the straight-wire appliance has set the standard. That the Tip-Edge appliance has this capability is due to the use of rectangular wire in an entirely new way, which is unique in orthodontics.¹ For reasons which will be fully explained, it has the intrinsic capability to produce a more accurate finish than existing bracket systems. To aid understanding, this and the hitherto established method of torquing with rectangular archwires will be compared.

Limitations of conventional torquing

A conventional edgewise or straight-wire bracket has a fixed vertical bracket slot dimension, into which freeplay can only be introduced by using undersized archwires. As is well known,

torque is achieved by the use of an active archwire of rectangular cross section, in which a third order torque deflection of the archwire will occur when inserted into the archwire slot. The torque force imparted will depend on the torque discrepancy between the archwire and the bracket, the elastic properties of the wire, and the degree to which the size of archwire fills the slot.

Although such a simple method may have served well over many generations, within its self-imposed limits, it is fundamentally flawed in one major area. Primarily, this is because the active component in torque production is the archwire itself, which is effectively acting as a spring. The rectangular wire is therefore required to provide the two-fold function of actively torquing those teeth requiring correction, while at the same time offering three-dimensional stability to the remainder. Combining these two conflicting functions in a single archwire is a physical impossibility. Many world respected researchers have identified and tried to address the problems of the unwanted reciprocals, whereby active torque imparted to a single unit, or quadrant, will inevitably impart unwanted secondary torque reactions in adjacent units, or groups of teeth, resulting in some 'round tripping'.²⁻¹³

Provided torque discrepancies are only minor, many orthodontists successfully ride through such problems, which are inherent in full rectangular archwire mechanics, rather than resorting to complicated segmental arch configurations, designed to eliminate such secondary reactions. However, there are other compromises in conventional torquing mechanics, which can less easily be ignored.

Returning, for a moment, to the conflicting requirements asked of a single rectangular wire in stabilizing some teeth while torquing others, there is a further dilemma concerning the ideal physical properties of the wire itself. For example, the relative flexibility of a nickel-titanium archwire may be preferable for progressive torquing with light forces. On the other hand, stainless steel might be the natural choice elsewhere in the arch for maintaining stability, particularly in the lateral and vertical dimensions, while being robust enough to support intra- or intermaxillary traction concurrently.

Lastly, there is the question of archwire size. It is customary, in the majority of straight-wire techniques, not to exceed archwires of .019 × .025 inch, within a standard .022 × .028 inch

bracket slot. This is partly to limit the active forces fed to a tooth by too heavy an archwire, but also to allow ease of insertion and removal. This degree of tolerance will equate to nearly 10 degrees of 'torque slop' between archwire and bracket slot.¹⁴ Although evidently regarded as a physiological safety feature, it may nonetheless result in up to 10 degrees of undertreatment, unless compensated by individualized torque adjustment in the archwire, or a modified torque prescription in the bracket itself.¹⁵

How does Tip-Edge torque?

It is essential first to understand that a Tip-Edge bracket cannot be torqued by an active archwire in the conventional manner, even with a fully closed bracket slot. Examination of the design of the bracket will explain why (Fig. 14.1). The intact upper and lower finishing surfaces in each bracket (see Fig. 3.2) are offset from one another, and are therefore never directly opposed. Insertion of an actively torqued rectangular archwire will therefore elevate one finishing surface and depress the other. In effect, the torquing effort in the archwire will have dispersed, by increasing the vertical dimension within the Tip-Edge slot. The net result will be a relapse of root uprighting in the mesio-distal direction, rather than any third order torque imparted to the root (Fig. 14.2). This is known as 'torque escape'.

Paradoxically, the selfsame bracket properties have opened new doors of possibility, allowing a new and entirely original method of torque delivery, simultaneous with tip correction. It represents a big step forward for orthodontics by relieving the rectangular wire of its double function: now the heavy base archwire becomes a passive platform, preserving three-dimensional rectangular control where necessary, while light auxiliary forces provide the flexibility to torque and tip each bracket into conformity with the archwire.

Originally, with the Rx-1 bracket, the Side-Winder spring provided the auxiliary force and this was the first time in orthodontics that an auxiliary spring, acting in the tip plane, had been shown to generate third order torque (those with an inter-

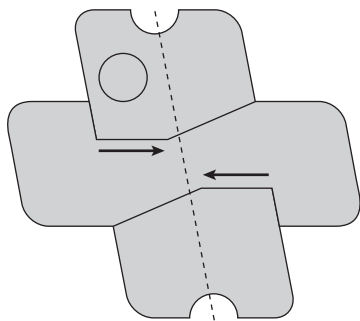


Fig. 14.1 The finishing surfaces of the bracket slot do not extend to the mid-point of the bracket.

est in the underlying mathematics are referred to Parkhouse & Parkhouse¹⁶). While the method might have appeared cumbersome, since it required a Side-Winder for each individual bracket, the Plus bracket has revolutionized Stage III by eliminating the springs altogether. Now, all torquing and tipping can be carried out more simply and less obtrusively with a nickel-titanium auxiliary archwire, threaded through the deep tunnels, beneath the overall security of a stainless rectangular main archwire. This contains the torque prescription to which each bracket will be conformed by the auxiliary.

So, here is how it happens: during the first two stages of treatment, the bracketed teeth will have been free to tip, as previously described, thereby opening the vertical slot dimension from its nominal .022 inches, up to a possible .028 inches, depending upon the degree of translation (Fig. 14.3). It will be observed, in clinical use, that intrusion of anterior teeth during overbite reduction also tends to result in some mesial root movement, which adds to the bracket opening effect. Overall, even a small amount of mesial root or distal crown tipping will open up the vertical dimension a significant amount, due to the geometry of the Tip-Edge bracket.

At the onset of Stage III, therefore, a stainless .0215 × .028 inch archwire can be fitted without difficulty, since the vertical dimension available to the archwire, within each slot, will be comfortably in excess of the vertical dimension of the archwire

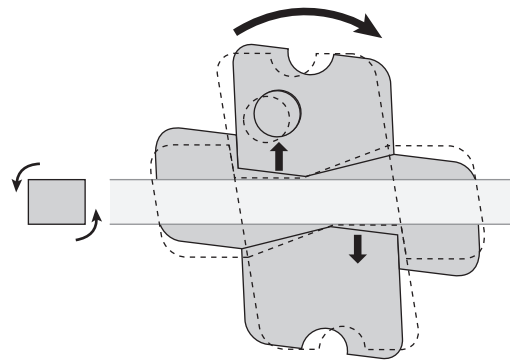


Fig. 14.2 'Torque escape', whereby an actively torqued rectangular archwire will reopen the vertical slot dimension, provoking second order root movement rather than third order torque.

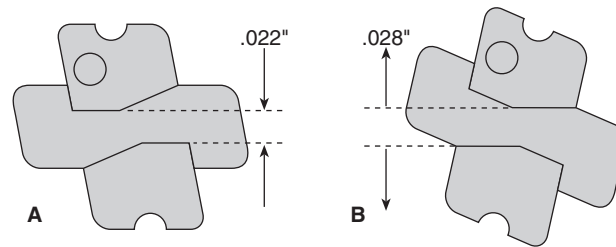


Fig. 14.3 During initial crown translation, the vertical archwire space will increase from .022 (A) up to a maximum .028 inches (B).

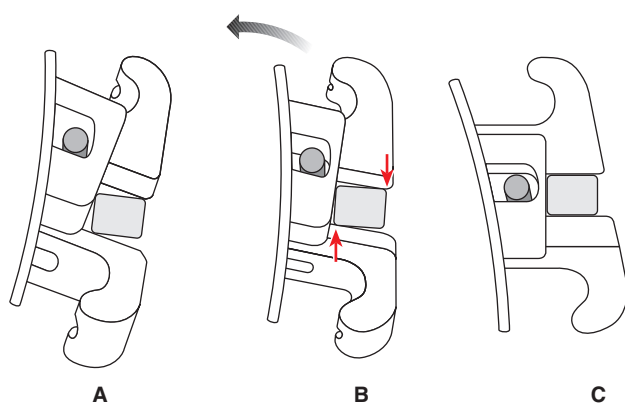


Fig. 14.4 Tip-Edge torquing. Viewed down the long axis of the archwire, a deep tunnel nickel–titanium auxiliary archwire is closing the vertical archwire space down again (i.e. previous Fig. 14.3B to Fig. 14.3A). (A) Initial engagement of rectangular wire. The vertical archwire space exceeds the vertical archwire dimension. There is no binding or archwire deflection. (B) The deep tunnel auxiliary begins to close down the vertical archwire space, achieving an offset two-point contact with the archwire (small arrows). From here, torque (large arrow) and tip will be delivered concurrently. (C) Final tip and torque are achieved simultaneously when the slot closes down completely onto the archwire.

itself. No torque will therefore be imparted at this point (Fig. 14.4A) and the archwire will not be deflected by any bracketed tooth. In fact, the only teeth subject to torque control from the outset will be the first molars, which wear rectangular buccal tubes.

The levelling properties of nickel–titanium wires will already be familiar to straight-wire orthodontists, so that the action of the deep tunnel auxiliary archwire will hold no mysteries: the vertical deflections of the auxiliary archwire (generally .014 inches round) in the deep tunnels will generate tip correction. Torque delivery is not a primary function of the auxiliary, but appears as a secondary force couple due to the interaction between the closing bracket slot and the rectangular main archwire.

After some initial correction of tip, a point is soon reached when further closing down of the bracket becomes obstructed by the opposite corners of the rectangular archwire. A two-point contact is thus established within the bracket, as indicated by the small red arrows (Fig. 14.4B). Because the deep tunnel auxiliary archwire is still active in the levelling plane, these two points are attempting to close down still further, exerting light pressure against the archwire. Due to the fact that the two pressure points are offset in relation to the torque plane (one on the upper labial and the other on the lower lingual edge of the archwire) a secondary torquing couple is generated, which will induce palatal root torque in the direction of the heavy arrow (Fig. 14.4B). The archwire can thus be regarded as the meat within a progressively closing sandwich. As the torque begins to express, so further tip correction progresses, the two-point contact being continuously maintained under light pressure,

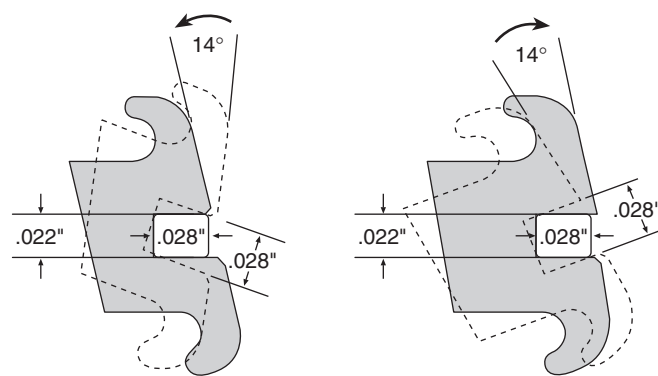


Fig. 14.5 A deep tunnel auxiliary archwire or a Side-Winder spring (neither shown) can recover 14 degrees of torque from either direction, without deflection or adjustment of the main archwire.

until finally, when the bracket becomes fully closed down to the vertical dimension of the archwire, the upper and lower flat surfaces of the bracket slot will be in contact with the flat upper and lower surfaces of the archwire (Fig. 14.4C). Now, all torque and tip will have been fully expressed, with no residual 'torque slop'. A deep tunnel auxiliary fitted correctly as described in Chapter 17 will automatically provide this action to all bracketed teeth.

For those still using the Rx-1 bracket, however, a Side-Winder spring will need to be added to each tooth requiring correction. Generally, all bracketed teeth should be included for best results. There is also the need to select each spring correctly for clockwise or counter-clockwise action. Each Side-Winder should always be orientated to un-tip the tooth, irrespective of which direction torque is required. The springs induce an exactly similar action to the deep tunnel wire in the Plus bracket, primarily correcting tip, the torque correcting concurrently as the bracket slot closes down on to the archwire.

It is worth noting, in the sequence illustrated in Figure 14.4, that the rectangular archwire cross section remains undeflected throughout the entire torquing process. (Strictly, a small deflection of the archwire will be induced reciprocally, by the eccentric two point pressure contact. However, the auxiliary forces are so light in relation to the torsional rigidity of the rectangular wire that this does not amount to clinical significance.) So, in practical terms we have, at last, a rectangular wire appliance that can torque teeth individually, without unwanted torque reactions to neighbouring teeth. Furthermore, it can torque either labially or lingually in the same manner. For example, if the illustration in Figure 14.4 had been a lateral incisor, requiring labial root torque rather than palatal root torque, the archwire pressure points (red arrows) would be reversed. The contacts would now be on the upper lingual and the lower labial edges of the archwire. A maximally open incisor bracket, at the beginning of Stage III, is capable of accommodating 14 degrees of torque discrepancy in either direction (a total range of 28 degrees) without deflecting the archwire (Fig. 14.5).

Both torque and tip actions are self-limited, according to the prescription in each bracket, by the approximation of upper and lower finishing surfaces to the archwire. However, a very small amount of overcorrection of tip (less than 1 degree) is permitted, since the .0125 inch vertical archwire dimension is fractionally smaller than the .022 inch archwire slot. When the auxiliary has fully expressed its tip correction, there will be zero torque discrepancy between bracket and archwire; the angle of torque finally adopted by the crown will therefore depend on the inclination of the rectangle of the archwire (as well as the prescription in the bracket base). Generally a zero torque angle in the archwire, defined as when the rectangular cross section lies flat and parallel to the mean occlusal plane, is appropriate to nearly all cases. This will yield the Rx-1 and Plus torque-in-base bracket prescription. However, we shall see later how this can be modified very simply in the archwire, usually across the anterior segments, to cater for certain skeletal situations.

The necessity to carry inventories of different bracket prescriptions is thus avoided.

Points to note

- The passive set of the rectangle in the archwire provides the benchmark to which each tooth will be torqued.
- Once a two-point contact is achieved (Fig. 14.4B), tip and torque delivery are unalterably related, according to the geometry of the bracket–archwire interface, the root apex describing a slightly curved path into its predetermined finished position.¹⁶
- Completion of torque and tip occurs simultaneously, for each tooth.
- If a bracket is prevented from expressing its torque fully (either by premature removal of the auxiliary, or by an unattainable torque target) there will be a corresponding shortfall in tip correction. The same is true vice versa: inadequate tip correction will prevent full torque correction.
- Because zero tolerance remains between bracket slot and rectangular archwire when each bracket has expressed and self-limited, inverted brackets are never required on palatally displaced upper lateral incisors. Reversing the torque by 16 degrees in this way is likely to impact the root against the labial plate. Because the auxiliary will then be prevented from closing the bracket down further, a shortfall of tip correction will result.
- High torque brackets are not required for similar reasons. It is easier to vary the torque set in the archwire, to compensate skeletal variations (as described in Chapter 16).
- It is a mistake to use an archwire of less than $.0215 \times .028$ inch gauge. Narrowing the width of the torquing platform retards the torquing progress. A thinner archwire will also be more liable to distortion by a Side-Winder spring and

will not provide the same degree of vertical and horizontal control throughout the arch. It will also be a sloppy fit in the molar tubes.

In summary

Use of rectangular wire as a passive benchmark, to which each bracket will be individually adapted, is a unique innovation. Is there any parallel with straight-wire practice? In fact, as will be seen, there is.

With edgewise or straight-wire bracket systems, it has long been recognized that even undersized rectangular archwires will generate some degree of torque control, so long as the archwires are active vertically during levelling. In such a situation, the flat upper and lower archwire surfaces will be working against opposite corners of the rectangular bracket slot, imparting some measure of torque control. Before the advent of nickel–titanium wires, it was accepted practice to engage rectangular stainless archwires in progressively larger sections, obtaining greater torque definition in the process (also with increasing forces). If it were possible to fill the slot completely, the torque prescription would be fully realized. In principle, therefore, the archwires are increased in size to fill the conventional bracket slot.

Tip-Edge approaches the same problem from a reverse perspective. Instead of increasing archwire thickness to fill the bracket, a Tip-Edge bracket shrinks its vertical dimension (under pressure from an auxiliary) to fit a full sized archwire, conforming to it precisely in all three dimensions.

Anchorage considerations

While the first two stages of treatment progress with dramatically small demands on anchorage, due to the fact that the teeth are permitted to tip, it should not be assumed that root uprighting is without its demands on anchorage. Indeed, these demands must be predicted and allowed for. For this reason, a cephalometric radiograph should always be taken prior to Stage III, and compared with the pretreatment radiograph and against final treatment objectives.

Because all adjacent teeth in each arch will be in contact, anchorage will no longer affect groups of teeth, but each arch as a whole, sometimes known as ‘contiguous anchorage’.¹⁷ Therefore, anchorage sequelae may influence the interarch relationship, which needs to be maintained in correction throughout the root uprighting phase, as well as influencing the facial profile.

With understanding and experience, it is possible to predict the likely direction and extent of anchorage shift, according to the direction and degree of root movement required in each arch, although there is individual variation, not least in the underlying growth pattern, which fundamentally affects the

interarch relationship. Nevertheless, in Class II cases, the normal expectation is for both arches to become more procumbent, particularly the maxillary arch.

This can be gauged from Figure 14.6, in which the arrows denote the required root corrections. In this first premolar extraction example, the lower arch is fairly straightforward, in that the reciprocal forces of the canine and second premolar partly cancel one another out, as the roots are being moved in opposite directions. Since the canine is the larger rooted tooth, however, there may still be an overall tendency towards mesial migration, particularly if it requires a greater angle of tip correction. The same applies to the upper arch, to which must be added the reciprocal of any incisor root torque, which will tend to advance the upper incisors, and so increase arch procumbence. A balance between the arches must therefore be struck, to preserve a correct interarch relationship. In a case treated by

means of intermaxillary elastics, these should be worn sufficiently to hold upper and lower incisors in contact; frequently this will involve elastics at night times only. Similarly a headgear patient will need to wear the headgear as many nights a week as it takes to maintain the same objective. In practice, headgear is required very seldom in Tip-Edge, particularly during the first two stages. However, it may very occasionally be a useful adjunct to boost anchorage during Stage III, where a Class II case threatens to become too procumbent if intermaxillary traction is continued.

From the foregoing it follows that, in Class II cases powered by intermaxillary elastics, Stage III should be approached from a somewhat retrusive position, in order to allow for the anchorage shift during root uprighting (Fig. 14.7), without calling for additional anchorage support from elsewhere. Anchorage requirements in other malocclusion types are generally less.

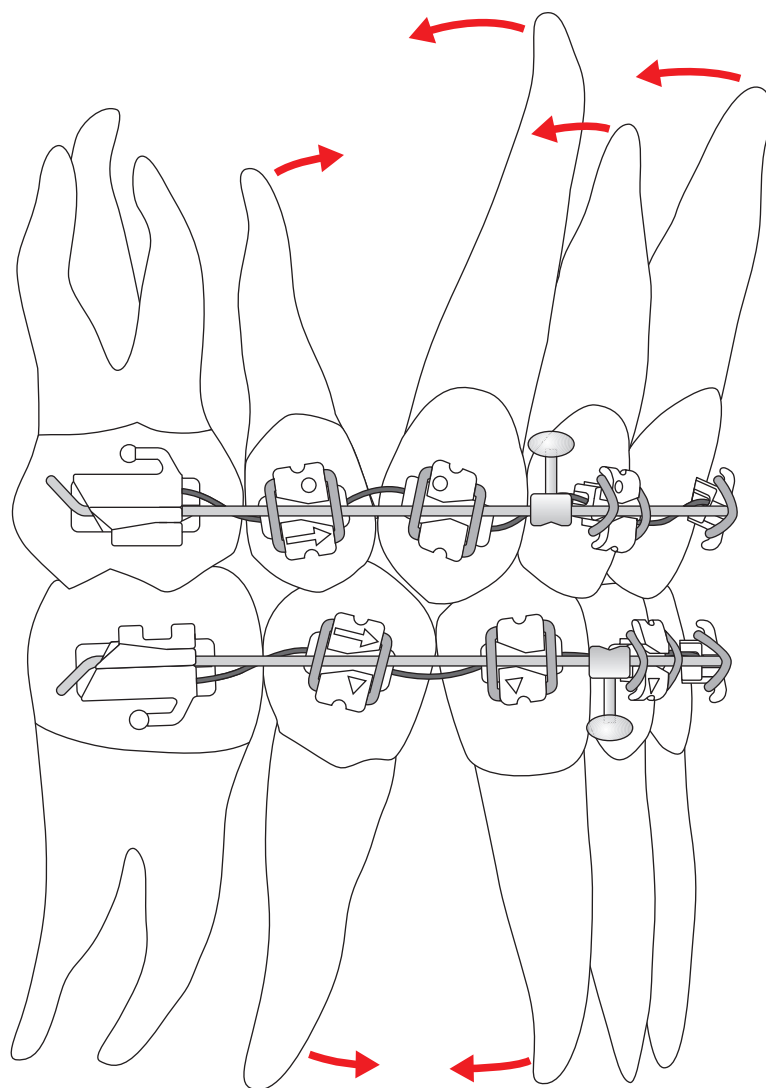


Fig. 14.6 Anchorage implications in a Class II four first premolar extraction case: the arrows indicate the various root movements, each of which affects anchorage.

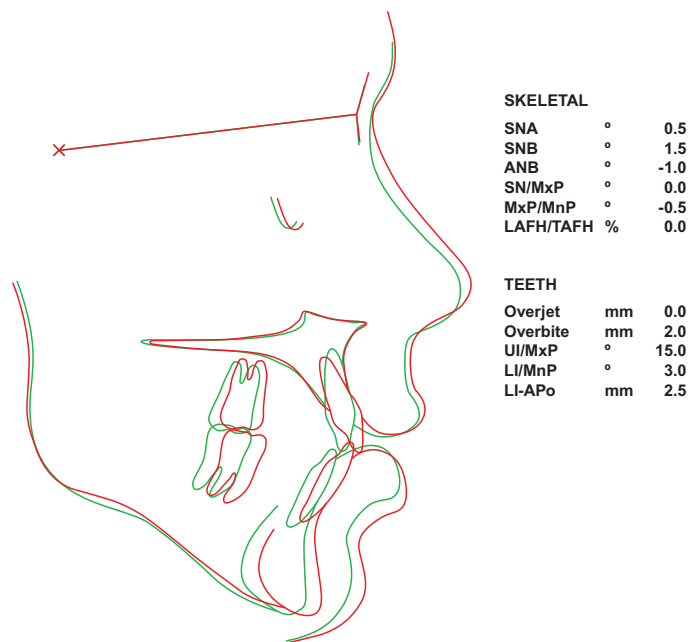


Fig. 14.7 Stage III anchorage considerations: over 7 months in Stage III in a four first premolar extraction case. The maxillary incisors have torqued 15 degrees, concurrent with distal root uprighting of all four canines, as depicted in Figure 14.6. Some forward projection of the dentition has taken place due to a combination of root corrections, mandibular growth and Class II intermaxillary elastics, worn at nights to maintain the interarch relationship.

References

- Parkhouse RC.** Rectangular wire and third order torque: a new perspective. *American Journal of Orthodontics* 1998; 113:421–430.
- Burstone CJ, Koenig HA.** Force systems from an ideal arch. *American Journal of Orthodontics* 1974; 65:270–289.
- Burstone CJ.** Rationale of the segmented arch. *American Journal of Orthodontics* 1962; 48:805–822.
- Burstone CJ.** The mechanics of the segmented arch techniques. *Angle Orthodontist* 1996; 36:99–120.
- Creekmore TD.** jco/interviews Dr Thomas D Creekmore on torque. *Journal of Clinical Orthodontics* 1979; 13:305–310.
- Demange C.** Equilibrium situations in bend force systems. *American Journal of Orthodontic and Dentofacial Orthopedics* 1990; 98:333–339.
- Isaacson RJ, Lindauer SJ, Rubenstein LK.** Moments with the edgewise appliance: incisor torque control. *American Journal of Orthodontic Dentofacial Orthopedics* 1993; 103:428–438.
- Isaacson RJ.** Creative arch wires and clinical conclusion. *Seminars in Orthodontics* 1995; 1:55–56.
- Isaacson RJ, Rebellato J.** Two-Couple orthodontic appliance systems: torquing arches. *Seminars in Orthodontics* 1995; 1:31–36.
- Rauch ED.** Torque and its application to orthodontics. *American Journal of Orthodontics* 1959; 45:817–830.
- Schrody DW.** A mechanical evaluation of buccal segment reaction to edgewise torque. *Angle Orthodontist* 1974; 44:120–126.
- Smith RJ, Burstone CJ.** Mechanics of tooth movement. *American Journal of Orthodontics* 1984; 85:294–307.
- Yoshikawa DK.** Biomechanical principles of tooth movement. *Dental Clinics of North America* 1981; 25:19–26.
- McLaughlin RP, Bennett JC, Trevisi HJ.** Systemized orthodontic treatment mechanics. Edinburgh: Mosby; 2001.
- Creekmore TD, Kunik RL.** Straight wire: the next generation. *American Journal of Orthodontics* 1993; 194:8–20.
- Parkhouse RC, Parkhouse PS.** *American Journal of Orthodontics and Dentofacial Orthopedics* 2001; 119:632–639.
- Kesling PC.** Expanding the Horizons of the Edgewise Archwire Slot. *American Journal of Orthodontics* 1989; 94:26–37.

CHAPTER 15

Stage III archwires

Choice of archwires	135
Arch width	135
Identifying the 'landmarks'	135
Archform	135
Traction hooks	136
Preparation of arch ends	137

Stage III archwires

At the setting up visit for Stage III, the patient may be only halfway through treatment, in terms of time taken. The orthodontist will be thinking up to 9 months ahead, since he will effectively be programming the final result. Care and attention at this point will be amply rewarded; once correctly set up, the third stage will progress and self-limit automatically, with a minimum of supervision and adjustment.

The various steps will be described in turn as a clinical sequence. In this and the following chapter, we begin with tailoring the archwires to shape and size, subsequently adjusting the passive torque setting to which the brackets will be conformed. There is, incidentally, no difference between Rx-1 and Plus in respect of the main archwires. The preparation is exactly the same for both.

Choice of archwires

Only one size of rectangular wire is ever used in Stage III. This is $.0215 \times .028$ inch 'Shiny Bright' stainless (the lateral dimension is actually $.027$ inch, to facilitate insertion in the molar tubes). However, such archwires come in two formats: plain or pretorqued. The choice between these will be described later and is summarized at the end of the next chapter. Basically, pretorqued will be indicated when bite sweeps are used, cancelling out the labial crown torque that would otherwise result from the sweeps, which would cause incisor proclination. These arches are also used for different reasons in Class III cases, where an atypical torque prescription may be appropriate to the anterior segments to maintain a positive overjet.

Arch width

The Standard (straight leg) arch shape should be used as the starting point. This will almost invariably be too narrow for the patient. However, it is easier to expand a rectangular arch, simply by placing it on a flat surface and widening the legs, rather than trying to contract it, which risks altering the torque. Initial expansion should be about 2 mm per side, across the molars (Fig. 15.1) in each arch. If gauged from the initial



Fig. 15.1 Before 'customizing', each archwire should be expanded to approximately 2 mm each side, across the first molars.

models, allowance should be made for any molar width corrections in the treatment design.

Identifying the 'landmarks'

The archwire can be rough cut for length against the models, so that it can be tried in comfortably. Holding the centreline marking precisely at the midline, the arch ends should now be cut accurately in the mouth, leaving 3 mm of wire protruding from the distal of each molar tube. With an arch marking crayon, the contacts between first molars and premolars should be identified on the archwire for the placement of toe-ins, and the contact between canines and lateral incisors should be marked for the addition of traction hooks (Fig. 15.2).

Archform

Approximately 5 degrees of lingual toe-in should be placed opposite the mesial molar contacts. This ensures that the arch-

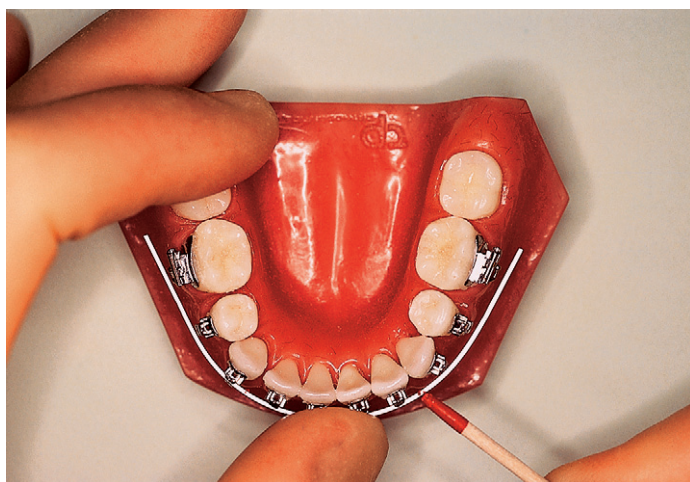


Fig. 15.2 Identifying the landmarks for hooks and toe-ins.

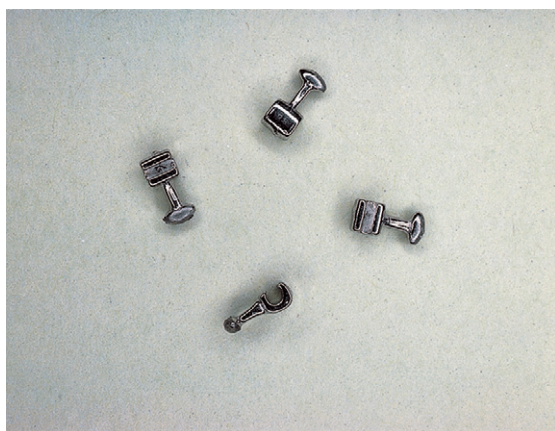


Fig. 15.3 T-shaped crimpable hooks.

wire enters the preangulated molar tubes at an equivalent angle to straight-wire archform. It will also restore archwire width across the molars to its desired measurement, while maintaining between 1 and 2 mm of expansion across the premolars, yet avoiding any increase in intercanine width. (This archform has been found to work well for UK patients, who generally have relatively narrow arches. However, those wishing to use the 'horseshoe shaped' straight-wire configuration may prefer to introduce some buccal segment curvature in lieu of toe-ins. For ease of fit, this should be preceded by a similar curvature to the .020 inch Stage II archwire, which can be introduced at its final adjustment at the previous visit, together with the molar offset and toe-ins to derotate the molars.)



Fig. 15.4 Lingual view of hook crimped with special plier.

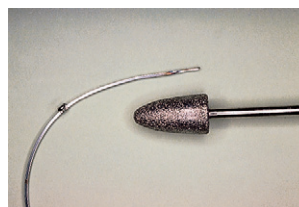


Fig. 15.5 The protruding distal archwire ends are thinned and annealed.



Fig. 15.6 Correlated Stage III archwires.

Traction hooks

These should be crimped to the wire midway between lateral incisor and canine brackets. The hooks should always point gingivally.

Such hooks are T-shaped, and therefore able to accept elastics or elastomerics from either direction (Fig. 15.3). They are seated from the buccal and need to be crimped tightly, using a special plier (Fig. 15.4). An internal tungsten coating prevents slippage along the wire. While the design of such hooks enables them to be crimped on in the mouth, this is not recommended. As will be seen later, the hooks act as useful 'markers' for the points at which torque is checked and adjusted. Squeezing them on afterwards may therefore disturb a previously placed torque setting.

Preparation of arch ends

This is vital, to enable easy insertion and removal. It is essential to cinch the arch ends gingivally during Stage III in all cases, as the reciprocal action of uprighting the roots will otherwise separate the crowns and introduce unwanted spacing.

The 3 mm of wire projecting distal to the first molar tubes will therefore need thinning and thorough annealing. A full thickness of wire is not necessary in a cinch back, and merely makes subsequent removal needlessly difficult. The distal ends can therefore be ground out from the lingual to

about half the original width (Fig. 15.5). Why from the lingual? It is because, when feeding the wire into a buccal tube, it is invariably the lingual corner of the cut end that catches in the tube.

As for annealing, this can be done with a flame, taking care not to extend the softened section too far mesially. Alternatively, the heat trapped in the distal section, generated by a high revving grinding wheel, can do the same.

Maxillary and mandibular arches should now be correlated (Fig. 15.6). They are now prepared, except for the torque and bite sweep.

Stage III: setting the torque

How to 'read' the torque	141
Torque in reduced overbite cases	141
Torque in increased overbite cases	141
Pretorqued archwires	142
Wiping the sweep, checking the torque	143
Class III cases	144
Severe skeletal Class II cases	145
Summary of pretorqued versus plain archwires	145
Case 9 A severely crowded Class I case with marked centreline discrepancies on a high mandibular angle Class II base treated with the Plus bracket	146
Case 10 A marked Class II division 1 malocclusion with increased overbite and enforced extraction of first permanent molars treated with the Plus bracket	150

Stage III: setting the torque

How to 'read' the torque

The torque set in any part of an archwire can easily be visualized by holding the prepared archwire within the beaks of a torquing plier, at the point at which torque is to be assessed. Testing anterior torque at the midline, with the archwire held 'back to front' (legs towards the plier handles) zero torque will be confirmed when the distal ends of the archwire lie midway between the handles. This simply demonstrates that the angle of the rectangle, at the point held, is aligned parallel to the occlusal plane. Figure 16.1 illustrates zero anterior torque, as tested at the midline.

In essence, each rectangular archwire in Tip-Edge has three torque segments: the incisor segment and both buccal segments. The hooks demarcate these three zones.

It is just as easy to read the torque in the buccal segments, simply by holding one leg at its distal end. Figure 16.2 demonstrates zero torque at the distal end being held, since the opposite distal end lies midway between the plier handles. Zero torque in the buccal segments is almost invariably desirable, rare exceptions being major arch width discrepancies or skeletal asymmetries.

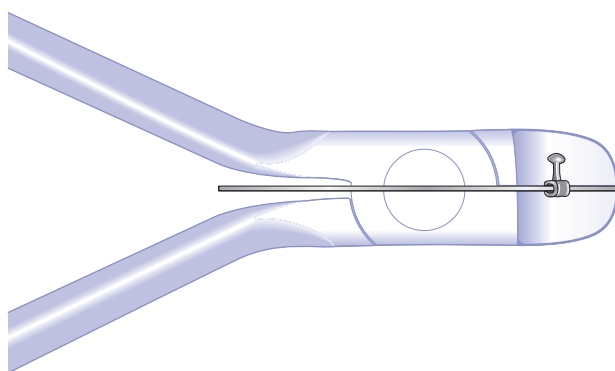


Fig. 16.1 A 'zero torque' archwire, held at the midline: the archwire ends distal to the first molars lie midway between the handles, denoting zero torque at the front.

Torque in reduced overbite cases

In cases in which the initial overbite was reduced, or open, no vertical bite sweeps will be required. Plain, flat, untorqued archwires can therefore be fitted, without torque adjustment. These will effectively be set at 'zero torque' throughout, as supplied, thus delivering the torque-in-base bracket prescription to each bracketed tooth individually. An exception may be in skeletal Class III cases, for which non-standard angulations may be preferred across the incisor segments, as will be described later in this chapter.

Using a mid-crown bonding position, flat archwires will produce a marginal increase in overbite, hence a small over-correction of a reduced overbite.

Torque in increased overbite cases

A zero torque archwire setting throughout will still be the aim. However, where overbite reduction has been required in Stage I (and therefore maintained with bite sweeps throughout Stage

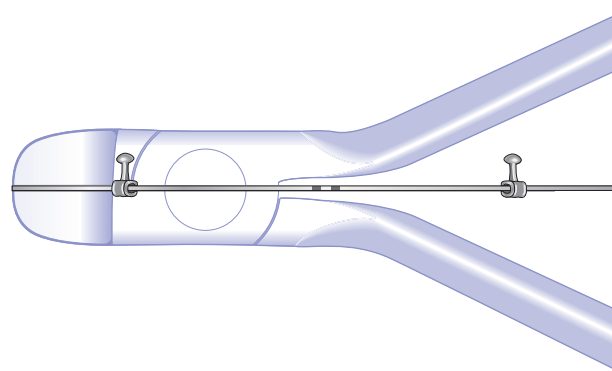


Fig. 16.2 The same archwire held at the distal: the opposite distal end lies midway between the handles, denoting zero torque at the buccal segment held.

II) it follows that vertical bite sweeps will be needed to maintain the reduced overbite during the third stage also. This introduces complications, since sweeping a vertical curvature along the buccal segments of any rectangular wire will automatically alter the torque setting at the front, relative to the occlusal plane, producing unwanted incisor proclination. This is shown in a lower archwire which has zero torque when flat (Fig. 16.3A), then after placement of a vertical bite sweep (Fig. 16.3B). It will be seen from Fig. 16.3B that the distal archwire ends no longer bisect the plier handles, but are now below them, denoting labial crown torque, which will cause proclination of the lower incisors.

What is therefore required is some lingual crown torque in the anterior segment of the archwire, to counteract the labial crown torque produced by the bite sweep, thereby restoring zero torque to the lower incisors. Zero torque should also be set along the buccal segments. In former times, this combination required intricate torque manipulations. Fortunately, now that we have pretorqued archwires, none of this is any longer necessary.

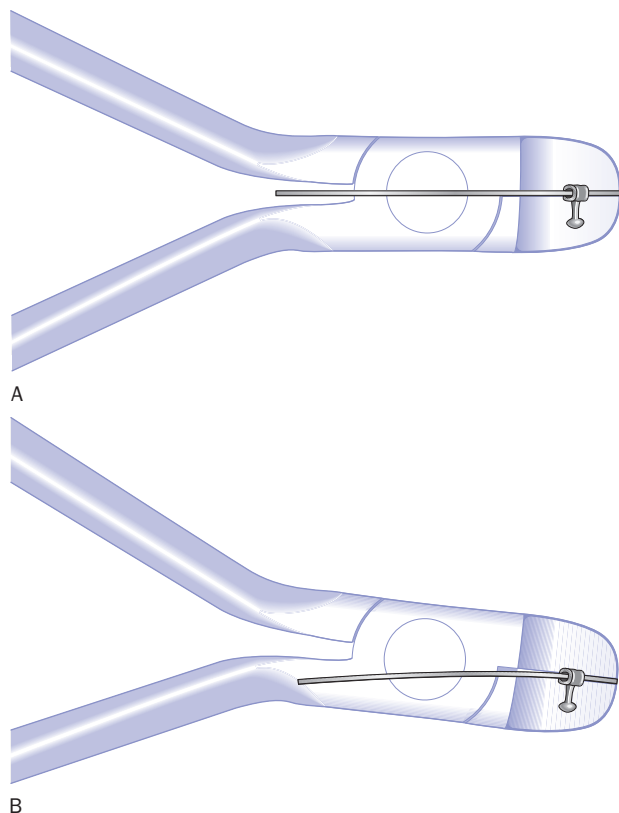


Fig. 16.3 (A) A zero torque lower archwire only remains zero torque when flat. (B) Placing a vertical bite sweep (reverse curve of Spee) automatically produces labial crown torque at the front (the distal archwire ends no longer lie midway between the handles).

Pretorqued archwires

These are identical dimensionally to the plain rectangular archwires already illustrated, but come with 5 degrees of lingual crown torque in the maxillary (Fig. 16.4) and 8 degrees of lingual crown torque in the mandibular arch (Fig. 16.5). Used in a case with an initially increased overbite, the purpose of the inbuilt retroclination will be to cancel out the proclination produced by the bite sweep (Fig. 16.6). Because of the continuity of the wire, the pretorque in each archwire extends overall, including the buccal segments (Fig. 16.7) from which it must later be removed. However, this avoids the necessity for the orthodontist to stock an inventory of different arch sizes; tailoring each archwire, and placing the hooks appropriately, allows one size to be adapted to all.

Pretorqued archwires are identified by their centreline markings, which appear on the upper surfaces only. The maxillary archwire therefore carries its single mark on the gingival surface, while the mandibular has double markings, both on the

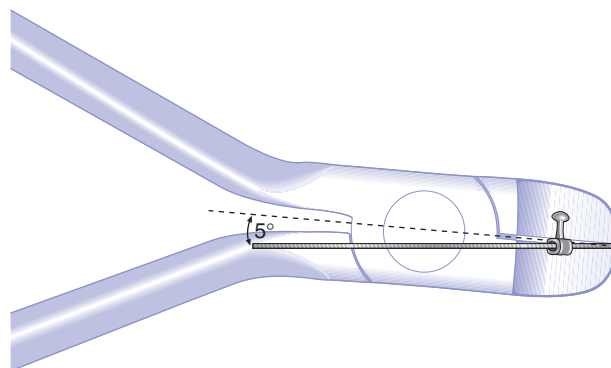


Fig. 16.4 A pretorqued maxillary archwire contains 5 degrees of lingual crown torque throughout.

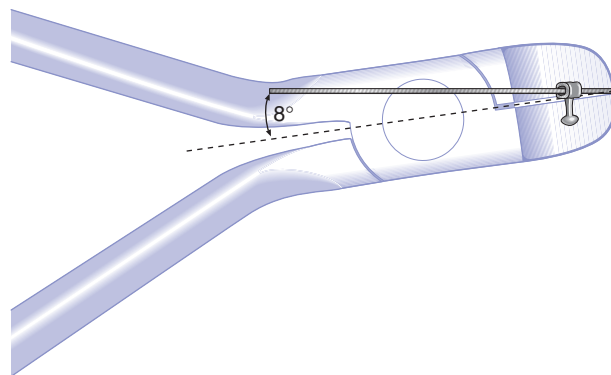


Fig. 16.5 A pretorqued mandibular archwire contains 8 degrees of lingual crown torque throughout.

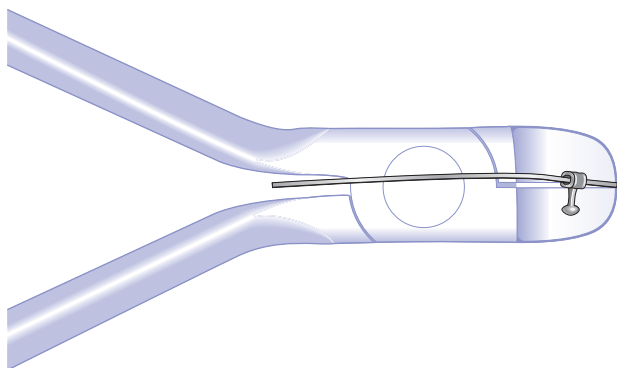


Fig. 16.6 When a vertical bite sweep is placed (to retain a previously reduced overbite) the in-built lingual crown torque cancels out the labial crown torque produced by the sweep. The distal ends lie midway between the handles.

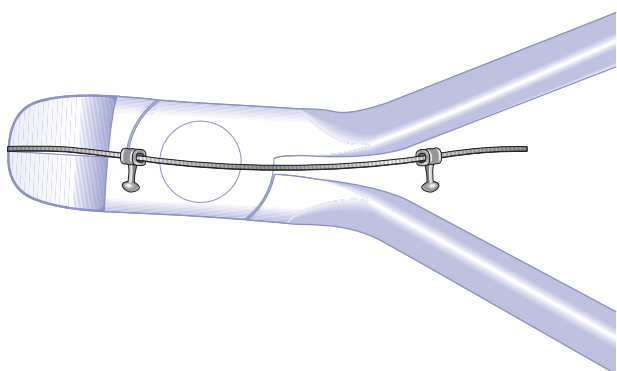


Fig. 16.7 Lingual crown pretorque extends down the buccal segments, where it will need to be returned to zero torque, as shown in Figure 16.12.



Fig. 16.8 Centreline markings on pretorqued archwires are on the upper surfaces only, to safeguard against accidental inversion. Fitting either archwire upside down would reverse the torque.

occlusal surface (Fig. 16.8). By this means, both upper and lower centreline markings will be visible to the operator when the archwires are in the mouth (Fig. 16.9) thereby avoiding accidental misfitting of an archwire upside down, which would, of course, reverse the torque.



Fig. 16.9 Other than some Class III cases (see text), upper and lower centreline markings on pretorqued archwires should be visible to the operator, confirming that neither archwire is fitted upside down.

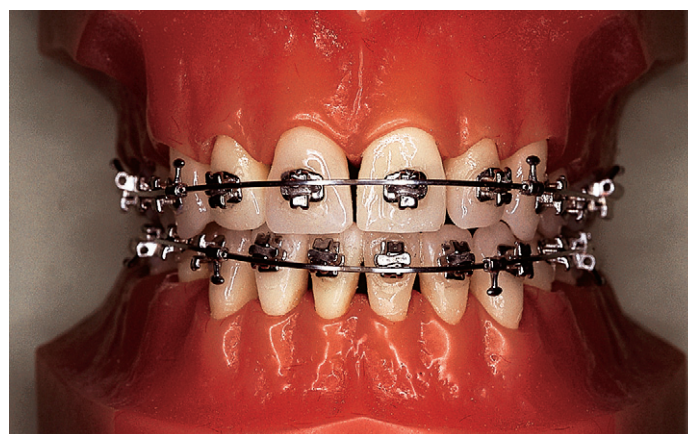


Fig. 16.10 A small amount of anterior archwire intrusion is all that is necessary to retain a previously deep bite throughout Stage III.

Wiping the sweep, checking the torque

The sweep comes first. The archwire should be held in a torquing plier, immediately mesial to the hook, and a vertical bite sweep curvature stroked into the buccal segment with thumb and finger, working distally, to produce a reverse curve of Spee in the lower arch and a 'rocking horse' curve in the upper. As with the Stage II bite sweep, most of the curvature should be along the canine and premolar regions, but not progressing into the molar tubes. In practice, the effect of the sharp distal end against the thumb or finger prevents this naturally! The same action should be repeated on the opposite side, to create a matching sweep. The amount of archwire intrusion at the front should normally amount to 1–2 mm (Fig. 16.10). A Class II division 2 case may require more, particularly in the maxillary arch.

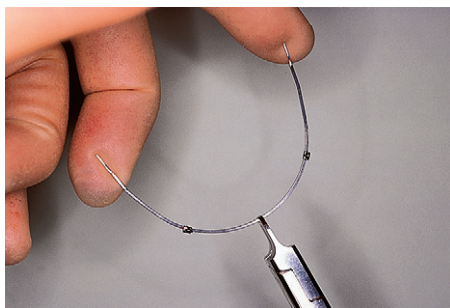


Fig. 16.11 A small amount of palatal root torque can be added to the upper incisor segment by elevating the tails of the archwire.

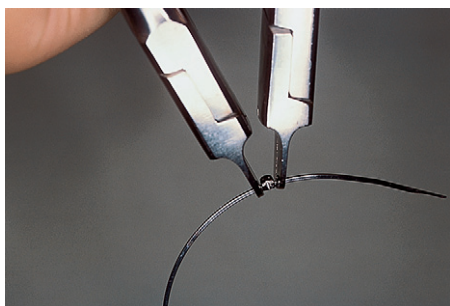


Fig. 16.12 Knocking out any residual pretorque in the buccal segment. The hooks are the landmarks: a small twist between the pliers at the hook restores the buccal segment to zero torque.

Now to check the torque. Firstly, check the incisor segment, by holding the wire at the midline, to see if there is zero torque (Fig. 16.6). Small torque adjustments can be made by gently deflecting the tails of the archwire vertically with thumb and finger, while holding the centreline steady in a plier (Fig. 16.11). (Distal ends up, in the maxillary arch, will increase torque and vice versa. In the mandibular arch, it is the opposite.)

Generally, a normal degree of bite sweep in the upper will automatically produce zero torque at the front, although in Class II division 2 cases it may be expedient to add a little more sweep, which will result in 2 or 3 degrees of extra torque, giving some overcorrection of interincisal angle (as in Case 6). In the lower, however, a normal amount of bite sweep may not quite cancel out the pretorque retroclination, and a degree or two of residual labial root torque, to which this equates, may be beneficial to lower incisor stability in Class II cases.

Lastly, any pretorque remaining in the buccal segments needs to be returned to zero torque. This is a simple adjustment, on each side, performed by placing torquing pliers either side of the hook, and in contact with it. A small twist between the pliers, along the long axis of the wire, can readily produce zero torque of the buccal segment (Fig. 16.12). The same applies to the opposite side.

Often, however, it will be found that any adjustment required to achieve zero buccal segment torque will be small, or even

unnecessary. This is because, when making the bite sweep, the action of sweeping around the curved section immediately distal to the hooks tends to reduce the pretorque in the distal section anyway, although not always sufficiently.

Finally, it is as well to re-check the bite sweep, in case this has been disturbed during the torque adjustment.

If the initial overbite was only mildly increased

Obviously, any orthodontist should stay aware of the starting malocclusion throughout treatment and will also know how readily an individual overbite has responded to reduction during Stage I. Those cases showing only a mild degree of overbite increase before treatment will have levelled out easily, without needing strong anchorage bends or bite sweeps. In such instances, the bite sweeps described above may be in excess of what is required. In such situations, it may be adequate to retain the reduction of a mild to moderate overbite with a flat unswept lower arch, confining a gentle sweep to the upper arch only. This simplifies treatment by requiring only a level zero torque archwire in the lower. If the upper archwire requires only a mild sweep it may be legitimate, in Class II cases, not to compensate this at the front. In other words, a zero torque rectangular archwire with a mild sweep will do the deed, while producing a little extra torque to the upper incisors, due to its sweep. Dr Kesling frequently uses this method, but this is partly because his cases often have a more incisal bonding height, measured from L-shaped bonding jigs, which may require a lesser degree of sweep overall.

Class III cases

Many straight-wire bracket manufacturers provide alternative anterior torque prescriptions to cater for Class III cases. It is far cheaper to vary the torque setting in the anterior segment with pretorqued archwires, rather than stocking up with different sets of brackets. This is particularly relevant to Class III cases. Here it may be desirable to compensate a prognathic mandible by treating the lower incisors to a retroclined position, while some proclination of the upper incisors may also need to be incorporated, in order to sustain a positive overjet. Such variations can easily be accommodated by using pretorqued archwires, but in a different way from that just described for compensating bite sweeps.

Typically, Class III malocclusions feature a reduction in overbite, for which bite sweeps will be inappropriate anyway. If the archwires are fitted unswept, therefore, the pretorque will be maintained across the anterior segments, to produce a non-standard incisor angulation.

In the mandibular arch, this is easy. The lower pretorqued archwire contains 8 degrees of lingual crown torque through-

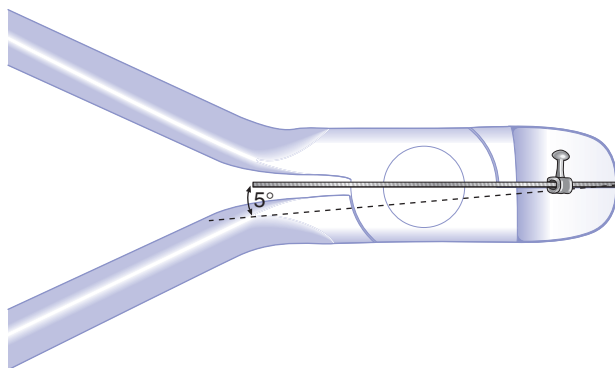


Fig. 16.13 Inverting a pretorqued upper archwire and fitting it flat will result in 5 degrees of incisor proclination, as may be appropriate to a Class III case.

out. Fitted without a bite sweep, this will cause the uprighting auxiliary to produce 8 degrees of retroclination (Fig. 16.5). The only torque adjustment required may be to produce zero torque in the buccal segments, achieved by means of the two pairs of torquing pliers, either side of the hooks, as described earlier (Fig. 16.12).

The maxillary arch is no less easy, but requires some 'inverted thinking'. This is because the pretorque set in the archwire is lingual crown torque, and retroclination is not what the upper incisors need in a Class III case. To reverse the torque, it is only necessary to flip the archwire upside down. By this means, 5 degrees of retroclination becomes 5 degrees of proclination (Fig. 16.13). An unswept upper pretorqued archwire, fitted upside down, is therefore generally suitable for the maxillary arch in Class III cases. This is therefore the sole instance when a centreline marking will not be visible to the operator on insertion.

An alternative approach to the latter, in a more severe Class III situation, might be to use a mandibular archwire the right way up in the maxillary arch. It would require further expansion for upper rather than lower arch use, but the same 8 degrees of retroclination intended for the lower will automatically become 8 degrees of proclination for the upper without the need to invert it! Really, rectangular wire is logical and not 'a black art'. Understanding the principles will enable each problem to be thought through from first principles.

Severe skeletal Class II cases

Having described anterior modification in archwire torque prescription to accommodate a Class III skeletal pattern, it might be asked whether similar consideration should be given to the severe skeletal Class II patient. In such cases it may not be possible to achieve correct torque values on upper incisors, due to the proximity of the palatal cortex. Equally, some proclination of the lower incisors may be beneficial to help camouflage a retrognathic mandible, which could easily be achieved by placing a bite sweep in a zero torque archwire.

However, in the author's experience it has seldom proved necessary to modify the archwires since, in the hierarchy of forces with Tip-Edge, the effect of intermaxillary elastics (which may well be required full-time through Stage III in adverse growth patterns) will overwhelm the activity of the light uprighting forces. In effect, the deep tunnel auxiliary will produce as much torque as it can, whereupon root movement will cease if an obstruction is encountered.

Theoretically, a slight shortfall in tip correction will result whenever torque is not fully expressed against the archwire, but in practice this is scarcely noticed. Neither has root resorption been noted during Stage III in such cases, any more than with other appliances. Because the torquing action of an uprighting auxiliary is so gentle, compared with archwire torquing in conventional brackets, the orthodontist need never fear the spectre of roots penetrating cortical bone as a result of a conflict in torque prescription.

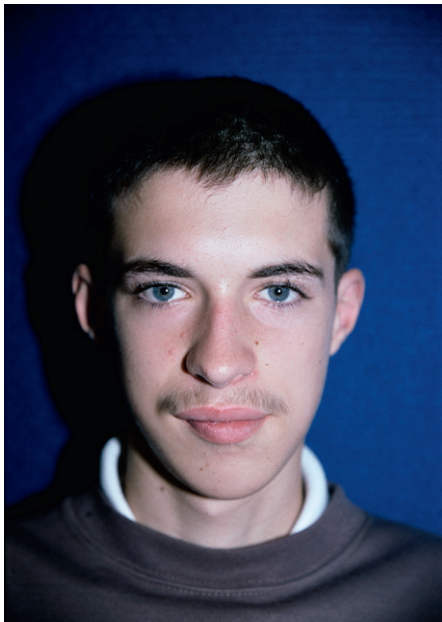
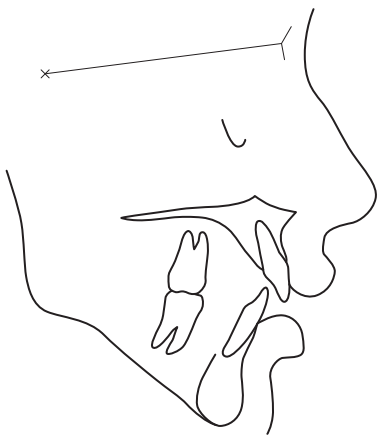
Summary of pretorqued versus plain archwires

- For reduced overbite and anterior open bite cases, choose plain arches, fitted flat.
- In cases that have required overbite reduction, vertical bite sweeps will be needed to maintain the reduced overbite. Therefore, pretorqued archwires will be necessary to cancel out the incisor proclination that would otherwise result from the bite sweeps.
- In Class III cases, with normal or reduced overbites, pretorqued arches can be used flat, without a sweep. However, the upper archwire will need to be inverted. Five degrees of proclination and 8 degrees of retroclination will then be given to the upper and lower incisors respectively.

Case 9

A severely crowded Class I case with marked centreline discrepancies on a high mandibular angle Class II base treated with the Plus bracket

Treated by Dr Joy Hickman



Pre-treatment			
SKELETAL		TEETH	
SNA	° 82.0	Overjet	mm 6.0
SNB	° 75.5	Overbite	mm 3.5
ANB	° 6.5	UI/MxP	° 105.5
SN/MxP	° 5.0	LI/MnP	° 88.5
MxP/MnP	° 37.0	LI-APo	mm -0.5
LAFH/TAFH	% 55.5		

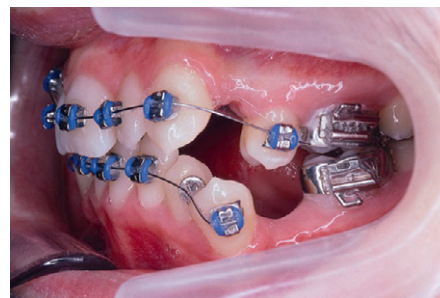
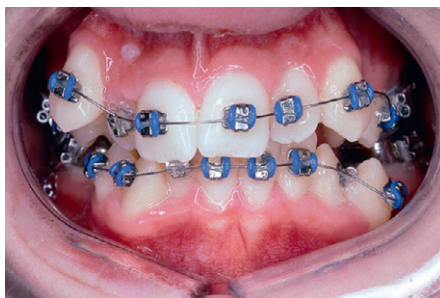
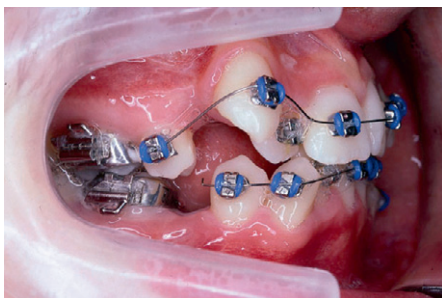
1

A 'high angle' case at 14 years 4 months, skeletally Class II (ANB angle 6.5 degrees) with some apparent mandibular asymmetry to the left.



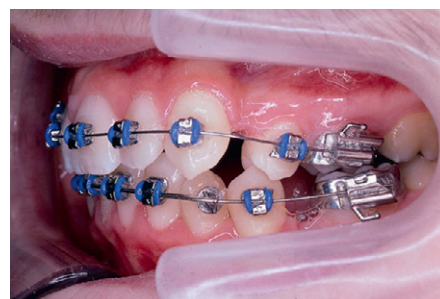
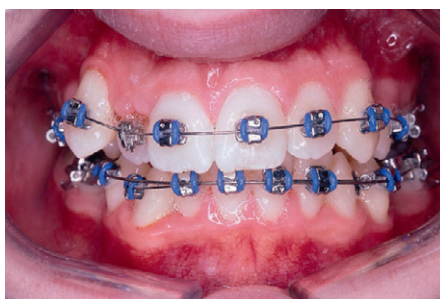
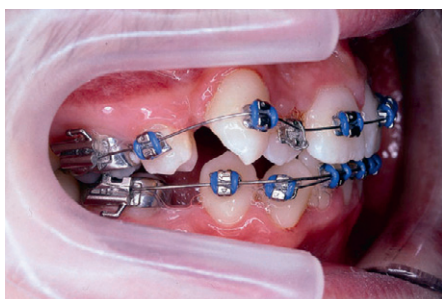
2

Large tooth size with big midline shifts, probably caused by premature deciduous loss, has resulted in severe crowding of the upper right and lower left quadrants. Clinical crowns are long. There is a slight increase in overjet at the midline. The maxillary left first molar is in palatal crossbite, causing a small mandibular displacement to the left on closing. Four first premolars would have been the natural extraction choice. However, the lower second premolar was congenitally absent on the left and diminutive on the right. This therefore dictated the extraction of the latter, together with the left deciduous second molar, instead of lower first premolars, to gain the necessary space.



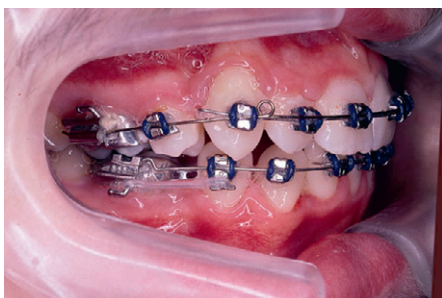
3

It is not always possible to start with stainless archwires in cases such as this, where there are big vertical and horizontal discrepancies. Here, a brief anterior aligning phase is needed first, with .012 inch nickel-titanium sectional archwires. This is sometimes referred to as a 'passive start', because anchor bends and intermaxillary traction cannot be applied. For this very reason, it is essential to step up to stainless steel archwires at the earliest opportunity, as precious space will otherwise be lost. The overbite is not an issue here, so the premolars are bonded from the outset (and the round molar tubes will not be used by any of the main archwires). A temporary attachment has been placed on the lower left canine until this can be accessed for a proper bracket.



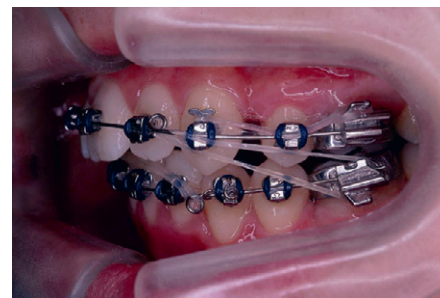
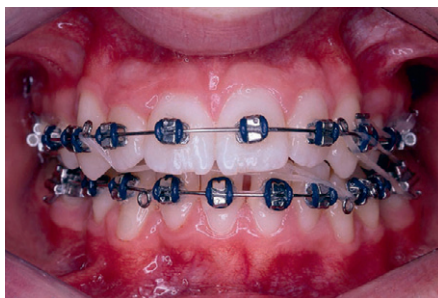
4

Shortly, the upper arch receives a full .016 inch nickel-titanium archwire, still loose tied towards the instanding right lateral incisor, while the lower has a flat .016 inch stainless archwire, together with a .014 inch underarch to align the canines.



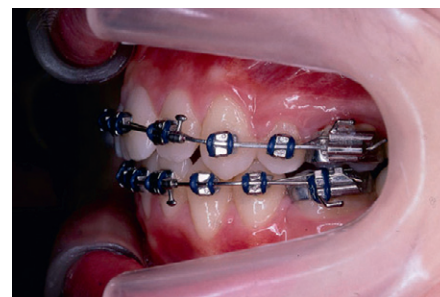
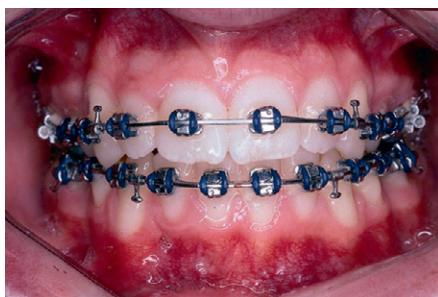
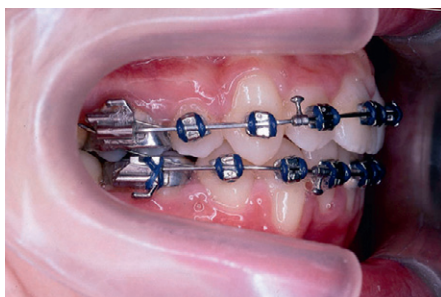
5

Now 3 months into treatment, both arches are into .016 inch high tensile Stage I archwires in combination with .014 inch nickel-titanium underarches for the instanding units. The lower archwire is stopped mesial to the first molar as a precaution against space loss, while an E-4 link retracts the right first premolar, applied via a Power Pin. Very light Class II intermaxillary traction, worn full time to the left side only, will begin upper centreline correction.



6

Stage II uses .020 inch stainless archwires. The left molar crossbite has been corrected but a slight 'scissors bite' of the right premolars reflects the underlying mandibular asymmetry. Transverse anterior elastics between the upper right and lower left cuspid circles, worn nights only, will assist the transverse discrepancy, continuing the left sided Class II elastics full time. A brake on the lower left canine (subsequently on the lateral incisor also) will boost lower centreline correction to the right. In addition, an E-Link to a Power Pin in the upper left canine provides direct retraction.



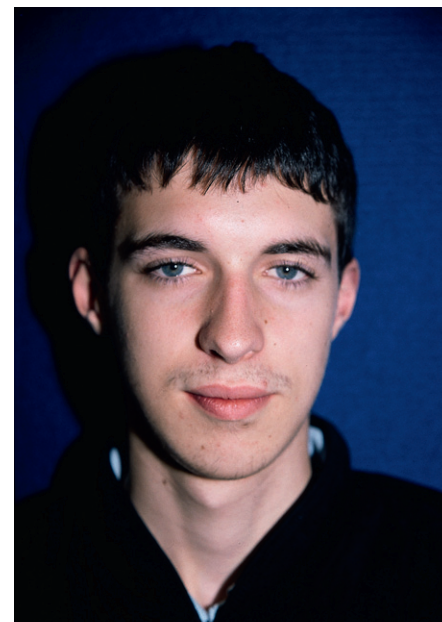
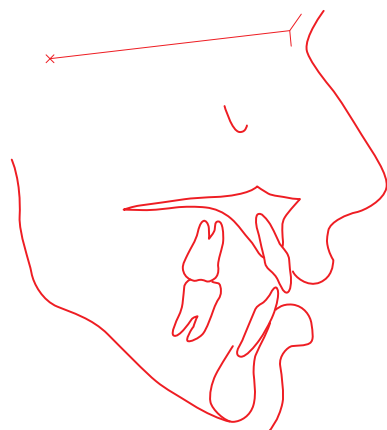
7

Because the initial overbite was only marginally increased, it is not necessary to sweep both upper and lower .0215 × .028 inch Stage III stainless archwires. The lower is therefore a zero torque archwire with no sweep, while the upper is a swept pretorqued archwire. Tip and torque corrections are powered by .014 inch nickel-titanium deep tunnel wires. To maximize uprighting of the upper second and lower first premolars, the auxiliary archwires terminate in the upper round molar tubes and the lower occlusal tie-wings (with 'safety first' elastomeric ties). The residual centreline discrepancy requires continuation of the anterior transverse elastics, worn nightly, between the upper right and lower left traction hooks.



8

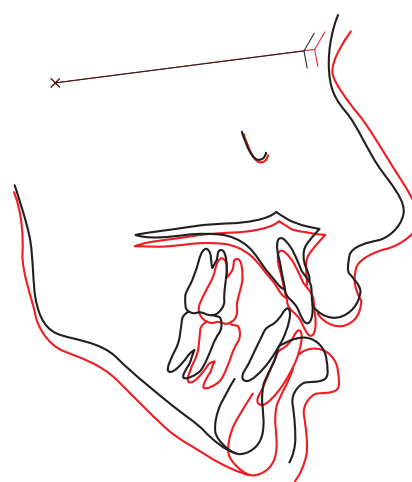
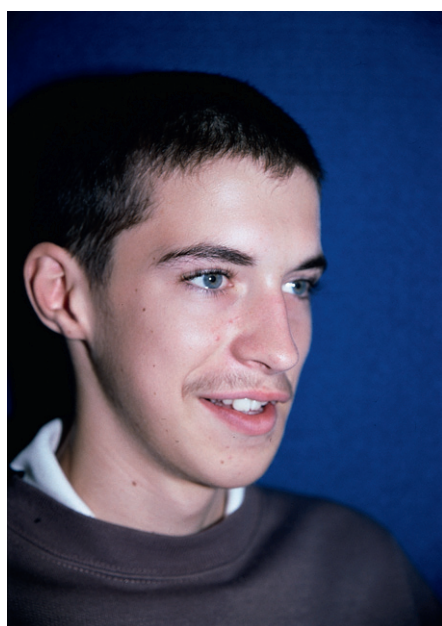
Active treatment has taken 17 months, including 7 months in Stage III. There is an excellent Class I occlusion on both sides, with no mandibular displacements.



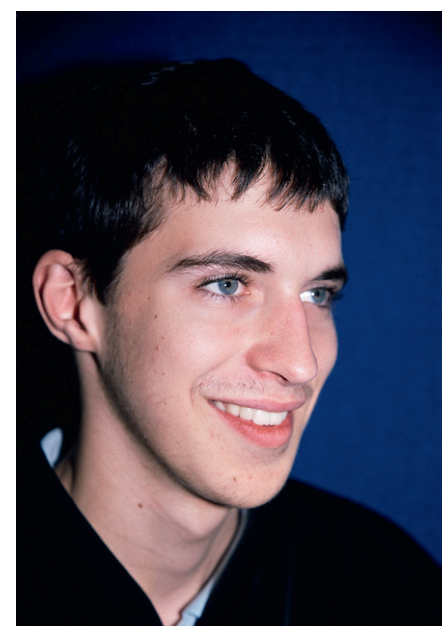
Post treatment				
SKELETAL		TEETH		
SNA	°	82.0	Overjet	mm 3.5
SNB	°	77.0	Overbite	mm 1.0
ANB	°	5.0	UI/MxP	° 105.0
SN/MxP	°	3.5	LI/MnP	° 85.0
MxP/MnP	°	39.0	LI-APo	mm 2.5
LAFH/TAFH	%	56.5		

9

Facial appearance has greatly improved.



Superimposition
Sella-Nasion at Sella



10

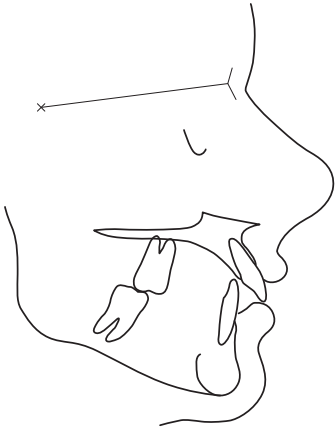
Predictably the downward growth pattern of the mandible has persisted, although the length of the mandible has increased considerably. There has been some bodily palatal movement of the upper incisors relative to the forward maxillary growth.

Treatment

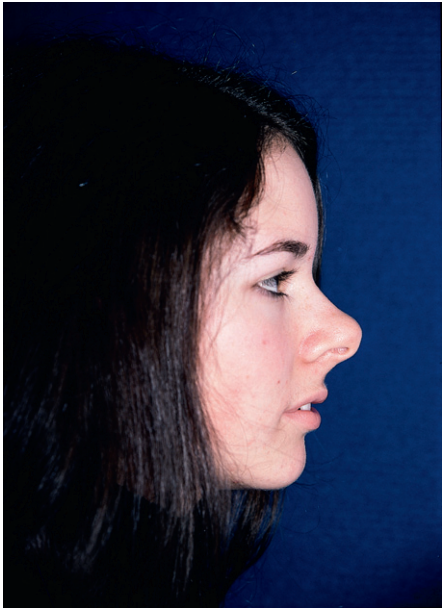
Treatment time = 1 year 7 months.
Routine adjustments = 12.
Main archwires used = 8 (4 upper, 4 lower).
Retention = Upper and lower removable retainers.

Case 10

A marked Class II division 1 malocclusion with increased overbite and enforced extraction of first permanent molars treated with the Plus bracket



Pre-treatment			
SKELETAL		TEETH	
SNA	° 87.5	Overjet	mm 11.0
SNB	° 85.0	Overbite	mm 5.0
ANB	° 3.0	UI/MxP	° 116.0
SN/MxP	° 5.5	LI/MnP	° 85.0
MxP/MnP	° 24.5	LI-APo	mm -2.0
LAFH/TAFH	% 54.5		





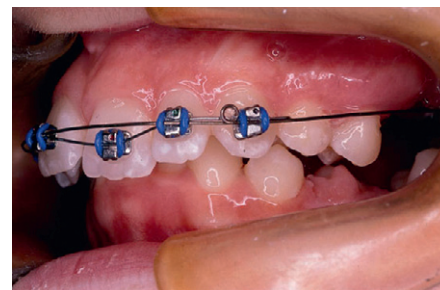
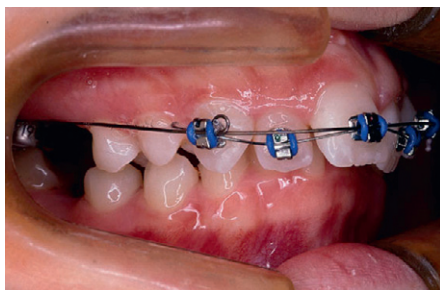
1

At 16 years 4 months, a difficult treatment problem. A major overjet (11 mm) with an increased complete overbite causing occasional palatal bite trauma. The skeletal pattern is less Class II than the overjet suggests. In a depleted lower arch, the lower incisors have dropped lingually and lie 2 mm behind the A–Po line.



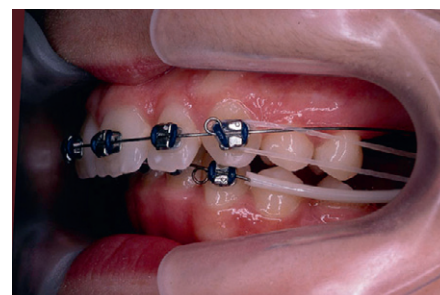
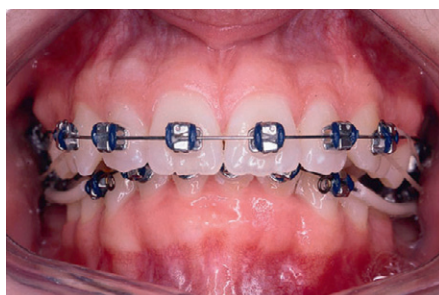
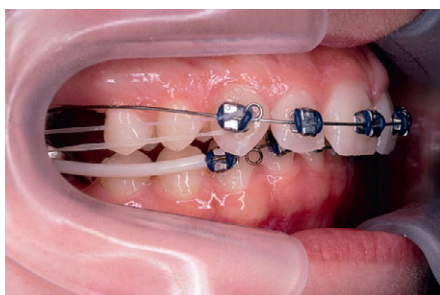
2

Unfortunately, both lower first permanent molars have been extracted previously due to poor prognosis. The upper labial segment is crowded and the canine and premolar relationship is virtually a full unit Class II. A lower deciduous molar is late shedding. Although treatment time will be extended by the need to extract first molars, rather than premolars, this is less of a disadvantage to Tip-Edge, with its light anchorage requirements, even in the more mature patient. Even though there are a greater number of upper teeth to be retracted, no headgear will be necessary in this case.



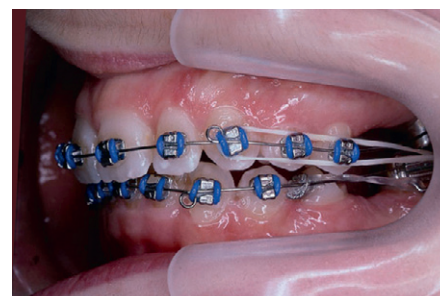
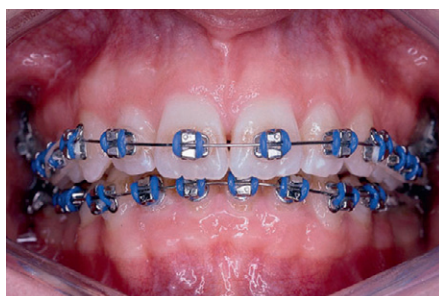
3

Ideally, both arches begin treatment together. However, the instanding upper right lateral incisor will interfere with a bracket on the lower right lateral. To prevent propping of the bite, lower arch treatment is deferred until the following visit. A .016 inch high tensile stainless upper arch is fitted with light anchor bends, merely to prevent the upper second molars from migrating mesially. A .014 inch nickel-titanium underarch lifts the instanding incisors clear of potential lower bracket contact.



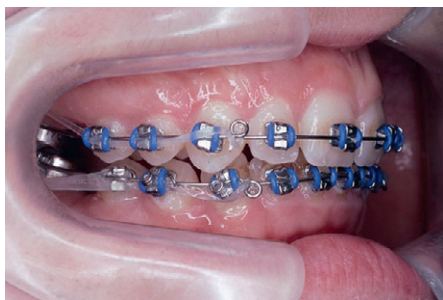
4

The following visit: Stage I begins, with a lower .016 inch lower archwire to match the upper. The premolars are omitted initially to facilitate overbite reduction. Anchorage bends are used to the round molar tubes with light (50 grams) Class II intermaxillary elastics, worn full time. The upper anchor bends are boosted to prevent extrusion of the upper anteriors, but the lower anchor bends are initially absent, because the mesially crown tipped lower second molars already impart an intrusive archwire deflection to the anterior segment. Because the upper labial segment is now well aligned, the canine brackets are ligated around the cuspid circles, whereas the lower canines are free to drift distally, to ease the mild irregularity of the lower incisors. Note that the sleeves on the mandibular archwire are for patient comfort only. Both are cut short so as not to obstruct mesial movement of the second molars.



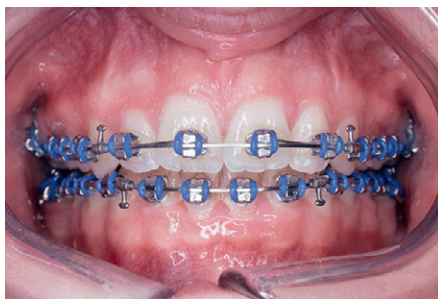
5

As sometimes happens with first molar extraction cases, the premolars have had to be bonded before Stage I is finished. The reason is that the long unprotected span of mandibular archwire across the premolars is vulnerable to bite deformation. This is retarding overbite reduction. The archwires are modified to bite sweeps in place of anchor bends, and are now in the rectangular second molar tubes. The lower left second premolar is using an E-Link from the molar hook to de-rotate it.



6

Stage II uses high tensile stainless archwires with bite sweeps, .020 inch in the upper, but .022 inch in the lower, somewhat expanded, where the extra stiffness will be useful in counteracting lingual rolling of the lower second molars during their journey forwards. Long E-links will close molar extraction spaces. 'Brakes' on lower canines and first premolars (later on second premolars also) prevent lingual movement of the lower labial segment.



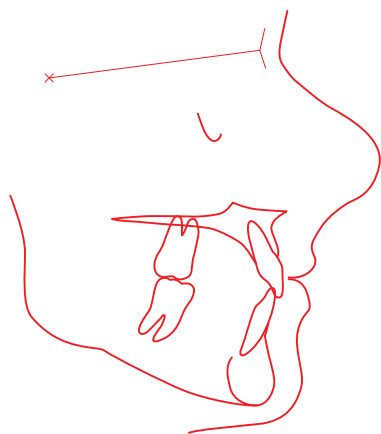
7

Closing molar spaces predictably takes longer, particularly in the later teenage years, but now, 1 year 5 months into treatment, Stage III begins (Dr Joy Hickman). The deep tunnels are threaded with .014 inch nickel-titanium wires, terminating in the occlusal tie-wings of the molar tubes. The main archwires are swept and compensated .0215 x .028 inch stainless. Light Class II elastics are worn at night. These can usefully be modified to 'Class II check' configuration (see page 172) to seat the posterior occlusion.



8

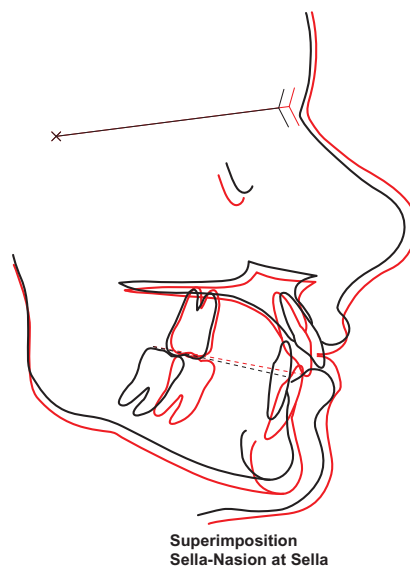
After 7 months in Stage III (which included an upgrade to an upper .016 inch nickel-titanium deep tunnel wire) active treatment is complete. This is the debond visit prior to settling.



SKELETAL		Post treatment		TEETH	
SNA	°	86.0		Overjet	mm 2.0
SNB	°	83.5		Overbite	mm 2.5
ANB	°	2.5		UI/MxP	° 109.0
SN/MxP	°	5.0		LI/MnP	° 94.5
MxP/MnP	°	23.5		LI-APo	mm 0.5
LAFH/TAHF	%	54.5			

9

The lips are now competent.



10

There has been some helpful mandibular growth and the lower incisors have been advanced to 0.5 mm in front of the A-Po line. The upper incisors show good torque control.

Treatment

Treatment time = 2 years.
 Routine adjustments = 15.
 Main archwires used = 6 (3 upper, 3 lower).
 Retention = upper and lower Hawleys, nights only (lower may require extended retention).

Stage III: threading the deep tunnels

The midline approach	157
The distal approach	158
The molar tubes	159
Which wires to use?	161
Hints and tips	161

Stage III: threading the deep tunnels

The all important difference between Plus and the Rx-1 bracket now comes into effect. Overall, Stage III remains the same in principle, whichever bracket is used. The distinction between the two is the power source for the root uprighting. Previous to Plus, individual Side-Winders did the job, generally one to each bracketed tooth, whereas with Plus, a full auxiliary archwire in the deep tunnels performs the same function. So it is a case of uprighting springs versus an uprighting wire. In this, the advantages of Plus will be quickly apparent. In retrospect, Stage III with all the springs did represent an uphill step for our patients to contend with. Although the appearance of the 'invisible' Side-Winders was not as conspicuous as the patients feared (unless wearing ceramic brackets) they were always aware of the coils labial to the brackets. These are also more difficult to keep clean and can become distorted by rough use. Although fitting the Side-Winders does get easier for the orthodontist with clinical experience, it is generally agreed, among those who have switched to Plus, that threading the auxiliary nickel-titanium archwire is an altogether more straightforward process. It is quicker too.

With springs, the main archwire goes in first, springs second. With Plus it is the opposite: the deep tunnels must be threaded before the rectangular archwire is fitted, for obvious reasons of accessibility. This has the advantage that if the main archwire should subsequently require adjustment for any reason, it can be removed and replaced directly without having to disturb the uprighting wire, let alone a host of springs!

While the threading of the deep tunnels will normally be at the same visit as the Stage III arches are fitted, readers will note that Dr Kesling sometimes fits the deep tunnel auxiliary at the previous appointment, at the end of Stage II, if his schedule permits. This allows uprighting to begin a little earlier, but care must be taken to ensure that the interval between appointments is kept short. Too long a timespan could allow the uprighting wire to close down the bracket slots to the point where insertion of the rectangular arch becomes difficult.

There are two accepted methods for threading the uprighting auxiliary wire. This can either be done from the mesial approach (usually from the midline) or from the distal of the last premolar. Each will be described in turn. The normal wire for this procedure will be a round .014 inch nickel-titanium, but the

choice of size and specification will be discussed later in this chapter.

The midline approach

This was the original method proposed when the Plus bracket was introduced, and the one used by the author (Figs 17.1–17.4). It is recommended for newcomers to the technique, since the threading is easy to see from the mesial of every bracket. The midline approach requires a preformed nickel-titanium archwire. This should be cut to length before threading, as there is no point threading an excess of wire and then having to cut off a sizeable length at the back. This can best be done by measuring the wire through the main archwire slots and cutting the ends approximately half way along the molar tubes. (When



Fig. 17.1 The starting position (midline approach). The four incisor deep tunnels have been threaded in reverse curvature. The nickel-titanium wire is safely contained within the brackets.

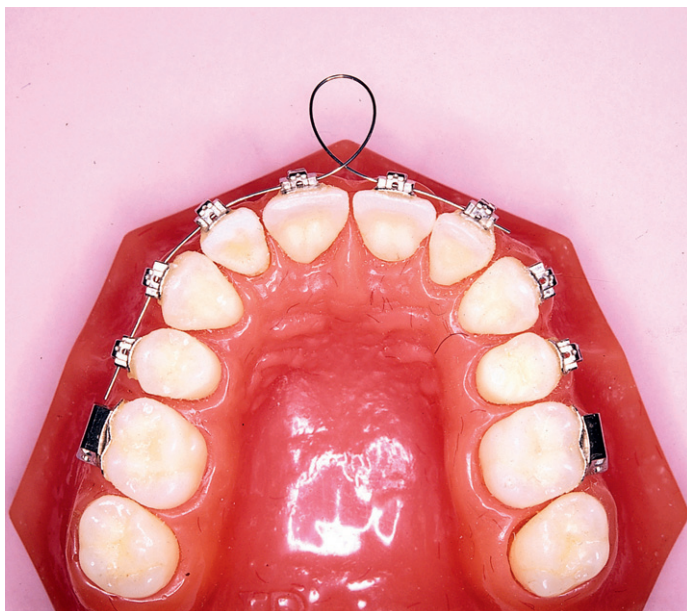


Fig. 17.2 The brackets of upper right quadrant have been threaded.



Fig. 17.3 The upper left quadrant has been threaded.

fitted in the deep tunnels, this will equate to the distal of the molar tubes.)

Beginning at the midline, the archwire should be threaded in reverse curvature (Fig. 17.1). This means that the upper left distal end is threaded through the patient's upper right central and lateral incisors and vice versa. Once the four upper incisors are threaded, the wire retains itself safely in position. There will of course be a large circle of surplus wire protruding at the midline at this stage. Threading backwards through the mesial of the canine and premolars is most efficiently done one side at a time, rather than alternating between sides, during which



Fig. 17.4 The deep tunnel wire is eased backwards into the round molar tubes (first premolar extraction case). The midline circle unwinds as it tightens and finally disappears. The rectangular main archwire can now be fitted.

the midline loop of wire shrinks in diameter (Figs 17.2 & 17.3). Finally, as the uprighting wire is seated fully home, the midline circle 'flips' and disappears (Fig. 17.4). It does this as the wire de-stresses by rotating 180 degrees along its length within the deep tunnels. The preformed arch curvature has now conformed to the curvature of the patient. The main arch can now be fitted as per the next chapter.

Care should be taken not to allow the midline loop to pull too tight, as this might cause some discomfort to the patient. It may be helpful to encourage the loop to unravel in the direction it needs to go, gently, between finger and thumb. This is seldom a problem in the upper arch, since the interspace between the upper central brackets is large. In the lower, however, if tooth size is particularly small, the midline interspace may be barely adequate. In such cases, it may be expedient to modify the technique by starting the threading between the lateral incisor and canine on one side, where the inter-bracket space will be larger. Alternatively the distal approach may be preferred (see below).

The distal approach

This requires a straight length of nickel–titanium wire, without a preformed curvature. Trying it for length across the main archwire slots, the wire should be cut slightly longer than with the previous method. This is to allow the last 3 mm of one end



Fig. 17.5 The distal approach inserts the deep tunnel wire from behind the last premolar and threads forward. Note the small annealed 'safety circle' at the free end of the nickel-titanium wire, which lies outside the patient's cheek. Right-handed orthodontists will find it easier to begin from the right side and vice versa.



Fig. 17.6 Threading has continued towards the patient's left, through all the deep tunnels and the left round molar tube, until the safety loop approaches the distal of the right premolar. There is necessarily some wire projecting beyond the left first molar tube.

to be annealed and bent into a small 'safety loop'. This will be the free end, which can rest outside the patient's cheek, without threat to the face, while the end to be threaded is inserted into the distal of the premolar bracket adjacent the molar (Fig. 17.5). Unless using a mirror, this process will be blind, but becomes easy with familiarity. (The deep tunnels are funnel shaped at both the mesial and distal for easy insertion either way.) Once through the premolar, threading continues forward, across the midline, then on distally down the opposite side. The threaded end should extend beyond the first molar by the time the safety loop is drawn close to the premolar bracket, where threading began (Fig. 17.6). The annealed loop can then be cut off distal to the premolar. Finally, the wire will need reversing a short distance to equilibrate the ends relative to the first molars (Fig. 17.7). The main archwire can now go in.



Fig. 17.7 Having cut off the safety circle, the deep tunnel wire is now centralized, by reversing it across to the patient's right, guiding the cut end into the round molar tube (first premolar extraction case). The rectangular main archwire is all ready for fitting.

This method has the advantage of eliminating the midline circle of wire. On the other hand, whereas the midline method requires each leg of the archwire to negotiate the bracketed teeth of one quadrant only, the distal approach eventually slides the wire through all the brackets across both quadrants. This will naturally generate more frictional resistance; exactly how much will depend upon how tipped the teeth are. From this it follows that the distal approach might be better suited to upgrading an auxiliary wire to a thicker one, mid-stage. The brackets would, by then, have been partially levelled by the previous auxiliary.

Each orthodontist will find his or her own preference of method.

The molar tubes

In the first cases treated with the Plus bracket, the uprighting wire simply terminated distal to the last premolar brackets. This sometimes resulted in undercorrection of the distal premolar, because this was receiving activation only from its mesial neighbour. Logically, the first molars need to be included, not for their own sakes (they are stabilized by the rectangular main archwire) but to assist in the uprighting of the adjacent premolar. How this is done will depend on which direction the premolar needs uprighting. If the first premolar has been



Fig. 17.8 The deep tunnel auxiliary (barely visible beneath the main archwire) terminates correctly in the round molar tubes, in this four first premolar extraction case, to assist mesial root uprighting of the second premolars.

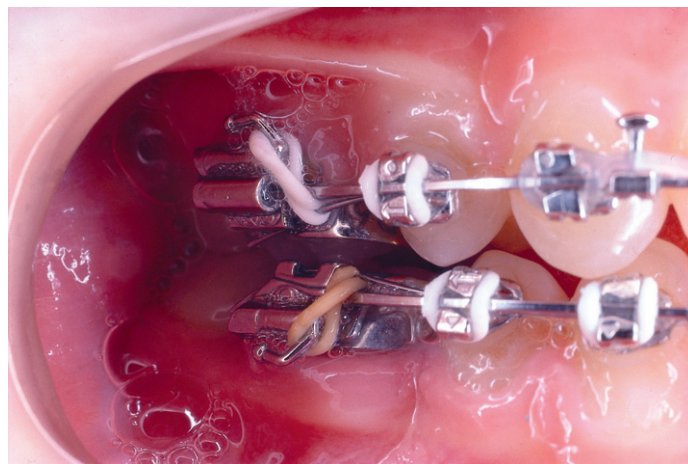


Fig. 17.9 In this second premolar extraction case, the first premolar roots need distal uprighting, for which an occlusal deflection of the deep tunnel wires at the distal is appropriate. These therefore rest in the occlusal tie wings of the first molar convertible tubes. The 'safety ties' are a precaution against displacement.

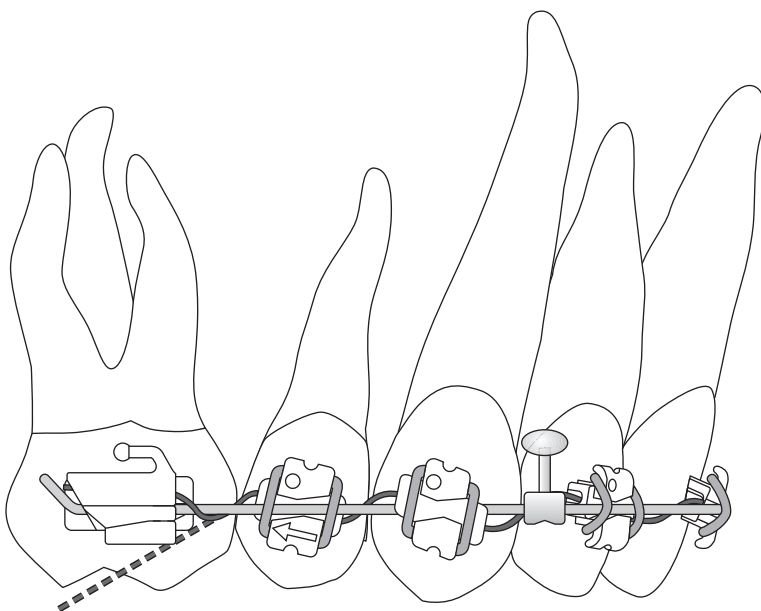


Fig. 17.10 A preferred method (Dr C. J. Kesling) where distal root tip of the adjacent premolar is required, is to thread the auxiliary over the main archwire, before tucking the end gingivally into the safety of the round molar tube. Some surplus wire will be needed to facilitate this, which should then be trimmed off at the back.

extracted, the second premolar will need mesial root uprighting. Feeding the distal end of the auxiliary archwire simply into the round molar tube will do this naturally (Fig. 17.8).

If the premolar root needs uprighting the other way (such as a first premolar following second premolar extraction, or a second premolar where a first molar has been lost, or in a non-extraction case) it follows that the distal end of the deep tunnel wire will need to be deflected occlusally. There are two ways of doing this.

The first is simply to rest the arch end on the occlusal surface of the molar double tube. In the author's experience, this is

easily done, particularly if convertible tubes are used, when the occlusal tie-wing offers a convenient slot for the end of the wire (Fig. 17.9). The 'figure of 8' retaining module shown is precautionary but generally unnecessary. Apparently, even when using the smoother non-convertible tubes, stability of the archwire ends is seldom a problem (C. K. Kesling, personal communication). However, Dr Christopher Kesling has since devised an alternative and preferable method, by looping the free end of the wire occlusally over the main archwire before inserting it into the safe haven of the round buccal tube (Fig. 17.10). This does require the orthodontist to allow 2–3 mm

more wire at the distal ends. The extra wire will be needed to make the turn around the main archwire after the main archwire has been placed. It also makes it easier to persuade the end into the tube.

Which wires to use?

The role of the deep tunnel wire is demanding of its properties. It requires to be very flexible on insertion, yet resistant to distortion. Its surface should be as smooth as possible to facilitate its passage through the tunnels and the forces it exerts during levelling should be as constant as possible. Only nickel–titanium wires can be considered in this context. Indeed, the Plus concept could not have succeeded without them.

When placing the uprighting wire at the start of Stage III, the brackets will already be in good horizontal alignment following Stage II, so that only vertical levelling of the deep tunnels will be required. It follows that the more severely tipped the teeth, the steeper will be the ups and downs in the threading process. Basically a .014 inch round nickel–titanium is the minimum required to achieve a full torque and tip expression. However, in a severe case, particularly with extractions, the teeth may be too tipped to thread a wire of this gauge comfortably. A possible solution is to begin with a similar wire of smaller diameter. A .012 inch nickel–titanium might be thought inadequate for the task, but in fact it performs well initially and is very easy to thread. It cannot, of course, bring the case to full conclusion, as the wire will level out before the case is finished, due to excess tolerance within the tunnels. This will therefore necessitate a change of uprighting wire to .014 or .016 inches. While this is not difficult in itself, it was not previously necessary to disturb the main archwire when using Side-Winders. In an attempt to avoid this ‘gear change’ in mid-stage, the author has used thermally activated .014 inch nickel–titanium uprighting wires with success. These are more expensive and only need to be considered when the brackets (usually the canines) will not readily accept a conventional nickel–titanium. In the martensitic state, they are extremely easy to thread and, theoretically at least, they exert less pressure under large deflections. Copper Ni-Ti 27degrees (Ormco) and Sentalloy (GAC) have both given good results.

The maximum possible size of uprighting wire will be .016 inch round and there may be indications for this, perhaps in the adult patient. It is more appropriate in the upper arch, where the anterior interspaces are larger and where torque requirements are likely to be greater.

Hints and tips

When sliding an uprighting wire through deep tunnels, there will be friction, as already mentioned, depending on how

tipped the brackets are. However, while actually threading a deep tunnel, there should be no resistance encountered within the bracket itself. The secret is to feed the wire through the tunnel at the correct angle. Failure to do this can result in the advancing end impacting against the ‘crossroads’ where the deep tunnel intersects the vertical slot (Fig. 17.11). In guiding the wire through the tunnel, therefore, the operator needs to take account of the inclination of the tipped bracket, also remembering to add up to 5 degrees for the cant (for vertical overcorrection) in the angle of the deep tunnels. This was described in Chapter 3. Once the end of the wire is safely in the tunnel mouth, a gentle deflection of the wire in the mesial interspace (generally occlusally and buccally, if threading from the front, except for a second premolar in a first premolar extraction case, which will be gingivally and buccally) will direct the end through the crossroads without resistance (Figs 17.12 & 17.13). Practice makes perfect and it quickly becomes second nature.

If using thermally activated wires, it is worth taking the trouble to test the properties of each wire at the outset. Unfortunately quality can vary, even within the same batch. Cooling

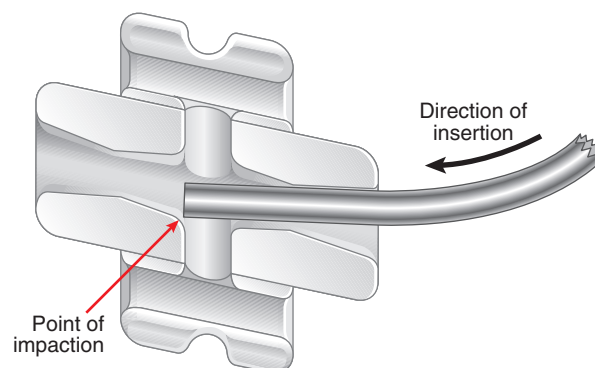


Fig. 17.11 Simply feeding the uprighting wire into the deep tunnel will invite impactation against the opposite wall of the vertical slot, particularly if the bracket is appreciably tipped distally.

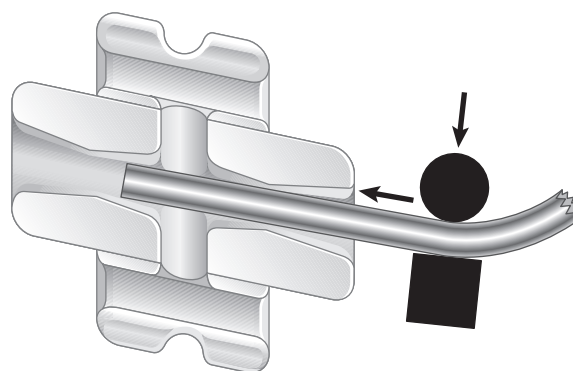


Fig. 17.12 Some guidance from a light wire plier in the interspace will easily achieve a frictionless crossing! (see next Figure).

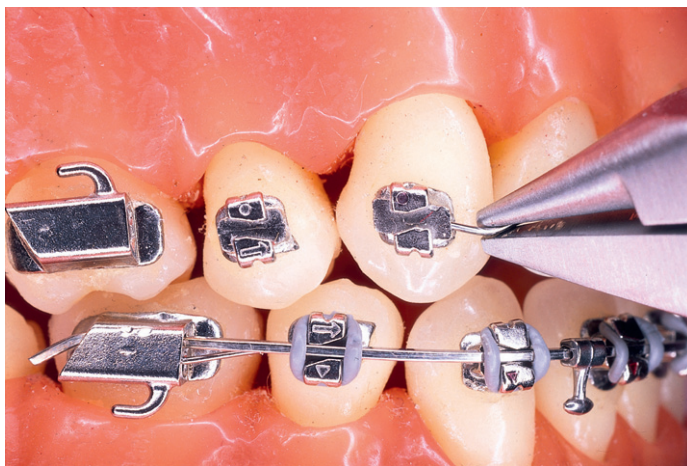


Fig. 17.13 In the case of an upper canine, the deflection of the auxiliary in the mesial interspace should be occlusally and a little buccally, to counteract the tip of the tooth (plus the 5 degree preangulation of the deep tunnel) and the reverse curvature.

with an air syringe should induce the martensitic state, whereupon the austenitic working resilience should be restored by immersion in warm water.

At the chairside, the assistant directs the cool air at each interspace in turn, where the wire is being threaded. Finally, if using the midline method, the remaining circle of wire between the centrals can be cooled, to allow it to flip more comfortably.

Removing the uprighting wire, at the end of Stage III, is quick and easy. Snipping it at the midline will allow each half to slide out mesially. If it is a thermally activated wire, which requires to be refitted (following a rebond, for instance) it can be removed intact by cooling it between the upper central incisors and sliding each side forward separately. In the lower arch, this is best done between the canine and lateral incisor.

Advantages of Plus Stage III over Rx-1

1. For the patient

- Better aesthetics – there is no detriment to appearance when switching to Stage III.
- The appliance is easier to keep clean without the springs, although care must be taken to brush behind the tunnel wires.

- More comfortable than springs, the labial profiles of which are noticeable to the patient, particularly on the incisors.

2. For the orthodontist

- Simpler to manipulate – less fiddly than springs.
- No chance of worsening tip by fitting the wrong Side-Winder spring.
- No springs to fall out or come unhooked.
- Makes it easier to change elastomeric modules.
- All bracketed teeth are automatically included in the uprighting process.
- Fewer co-operation problems. Patients are not tempted to interfere and cause damage, as they can with springs.
- Better rotational control. Deep tunnels act like self-latching edgewise brackets in maintaining rotational stability throughout the uprighting phase, whereas a distorted Side-Winder can cause a small mesial rotation.
- The main archwire is immediately accessible for adjustment, if required, without first having to remove all the springs.
- Will be compatible with the inventory of a conventional edgewise orthodontist in the event of transfer.

3. For the assistant

- A holiday! No springs to sort out.

Disadvantages of Plus

- It costs more. Pricing may vary, but the Plus bracket is more expensive to manufacture than the Rx-1. This is because it is a high quality metal injection moulding, instead of a conventional casting. As against this, the extra cost will be partially offset by a reduction in the number of Side-Winders used (now confined to braking or Power Tipping in the earlier stages).
- The strength of residual activation may be less than is achievable with Side-Winders. This is because springs can be reactivated or boosted (see 'hyperactivation' in Chapter 19) which a deep tunnel wire cannot.
- Clinical experience suggests that the properties of thermally activated nickel–titanium wires tend to be inconsistent.

Stage III: fitting the archwires (and Side-Winders)

Testing for molar torque	165
Cinchbacks	166
Side-Winders	167
Removing the archwires	168

Stage III: fitting the archwires (and Side-Winders)

With the Plus bracket, the main archwires should only be fitted after the nickel–titanium uprighting wires have been placed in the deep tunnels. The rectangular wires should go in easily, so long as levelling and alignment has been satisfactorily maintained during the second stage. Resistance when attempting to enter the molar tubes is almost invariably due to failure to derotate the molars at the last Stage II adjustment.

Quite contrary to what might be expected with conventional brackets, all bracketed teeth should accept the $.0215 \times .028$ inch archwire readily, since their vertical archwire space will be increased beyond the vertical dimension of the wire. Indeed, at the fit visit, none of the bracketed teeth will ‘know’ that they are engaged with rectangular wire, for there will be no binding. No torque effect will be imparted either, until the deep tunnel uprighting wire sets to work, because the archwire itself is passive in the brackets.

However, this is not so with the first molars, which are subject to accurate torque control from the moment the archwire is fitted.

Testing for molar torque

Before fitting the archwire, it is important to assess whether there is any torque discrepancy between the archwire and the buccal tubes. Any active torque thus found should be recorded in the patient’s notes. Just as with any edgewise-based appliance, the test is to insert the distal end of the archwire into the buccal tube on one side only, keeping clear of the brackets, and then observing the height of the free distal end on the opposite side, relative to its buccal tube (Fig. 18.1). Any height discrepancy at this point will denote the direction and extent of the torque discrepancy in the molar engaged. The same test should then be applied to the opposite first molar.

Should any torque discrepancy be apparent, this does not necessarily imply a fault requiring rectification. The temptation to adjust the torque in the buccal segment away from zero, to make it passive in the tube, should generally be resisted. More often than not, the archwire may be telling the orthodontist something about the molars. Have the mandibular molars inclined lingually, for instance? If so, a zero torque setting in



Fig. 18.1 Testing for torque discrepancy in a molar tube.

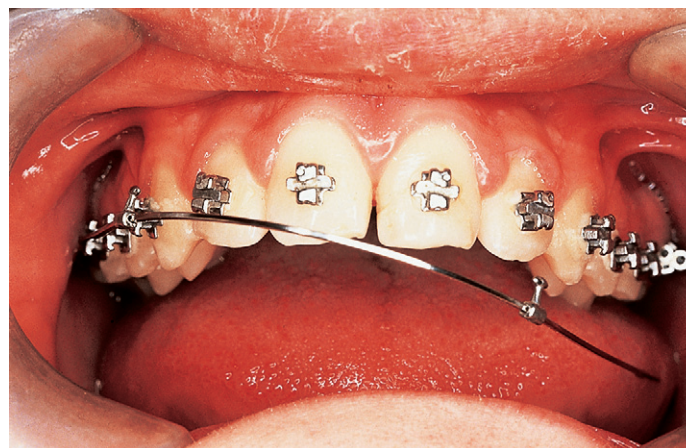


Fig. 18.2 A major torque discrepancy is revealed between this zero torque archwire and the upper second molar tube in this Rx-1 bracket case (see text).

the archwire will help to upright them. Figure 18.2 shows the engagement of an upper second molar in a first molar extraction case, in which the palatal cusp has dropped; again, this will be corrected automatically during the stage, without need for archwire adjustment. Sometimes when fitting the archwires,

if there is a considerable torque discrepancy, it may be necessary to flex the archwire slightly about its long axis as it is being inserted (with a light wire or torquing plier) to help it slide freely into its buccal tube.

The question may be asked as to whether such a solid rectangular wire, imparting torque to a molar, is too heavy to be safe, either to the molar or to adjacent teeth. The unexpected answer is that, because the bracket slots are opened up vertically, and therefore not 'grabbing' the archwire at any point, the interbracket span is effectively from one first molar all the way round to the other. The bracketed teeth themselves remain unaffected.

Cinchbacks

As previously explained, all cases require cinchbacks at the distal arch ends, to prevent unwanted spaces opening up as a reaction to root uprighting. However, the management of these cinchbacks is also critical to preventing tight contacts, which will halt progress and may induce rotations, particularly if using springs. In this, it should be remembered that crowns require additional arch length as they upright mesio-distally, particularly canines and premolars. This should be allowed for in the cinchback. In all cases, it is strongly recommended that the cinchbacks should be placed and tested at the midline, before fitting the elastomeric modules. This makes it easy to ascertain visually how much, if any, free space will be admitted.

A tiny amount of space (0.5–1 mm) somewhere in each arch is good. If this is already present, the annealed arch ends should be turned gingivally, precisely at the point of exit from the tube. This is best done with a light wire plier, held open. With the square beak resting gingival to the tube and the round beak on the protruding annealed arch end (Fig. 18.3A) a gentle squeeze will seal the space closed (Fig. 18.3B). This can be verified at the midline: it should not be possible to displace the archwire labially with a plier. This is a much more accurate method than clenching the distal end between both beaks and turning it gingivally, which can overtighten the contacts.

If, however, no space is available anywhere in the arch and particularly if there are overlapping contacts, a very small amount of wire will need to be fed forward from the back, through the molar tube. This can be accurately controlled by placing the fine tips of a light wire plier against the contact point between the molar and premolar. Grasping the archwire firmly, as close to the molar tube as possible, a gentle forward rotation of the handles should ease the archwire mesially just a fraction (Fig. 18.4). This may be repeated on the opposite side. The result can be tested at the midline, when it should be possible to displace the archwire labially from the bracket by about half its thickness. The cinchback will need to be restored lightly to its new position, before placing the elastomeric modules in the usual manner.

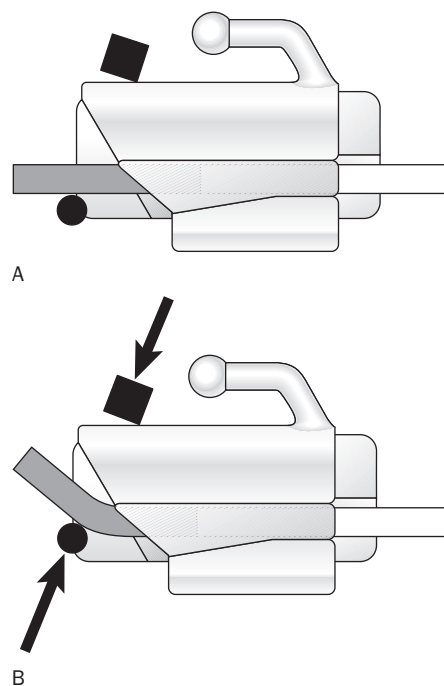


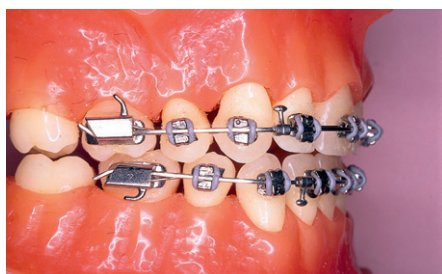
Fig. 18.3 Sealing the space closed at the distal archwire ends. (A) A light wire plier held open, when squeezed partially closed, will turn the annealed end gingivally, precisely at its point of exit from the tube (B).



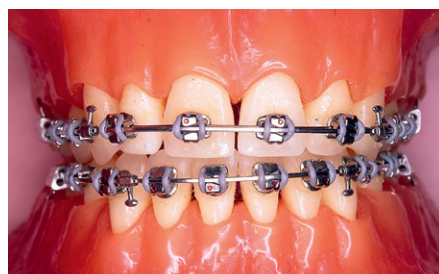
Fig. 18.4 The rotating action of a fine-beak plier will ease an archwire mesially without patient discomfort.

The success of a cinchback does depend on accurate annealing. This should extend just into the distal of the tube. Any unannealed wire projecting distally will resist bending just where it matters most, which may invite spacing by leaving a straight section. Alternatively, bending an unannealed section by force will make the archwire difficult to remove later. Bending a wire flat against the distal incline of the tubes also makes it hard to remove. Generally, no cinchback with rectangular wire need ever exceed 30 degrees.

Figure 18.5 shows how Stage III should look, when set up for a first premolar extraction case using the Plus system. Comparison with Figure 18.6 illustrates the differences between Plus and its predecessor, and how it used to be with Rx-1 brackets.



A



B



C

Fig 18.5 How a Plus Stage III should look in a four first premolar extraction case.



A



B



C

Fig. 18.6 With Rx-1, Side-Winder arms point mesially, the main exception being second premolars in a first premolar extraction case.

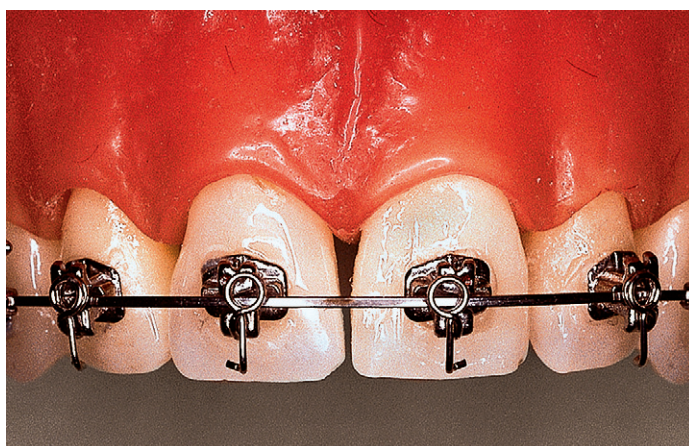


Fig. 18.7 Full activation of Side-Winders is appropriate to incisors requiring torque control.



Fig. 18.8 Approximately 45 degrees of activation is generally sufficient on canines, to avoid generating a mesial crown reaction.

Side-Winders

(This section can be skipped by Plus users, but is included for the benefit of those continuing to use the Rx-1 bracket.)

Invisible Side-Winders are fitted first, the modules second. The selection of the correct springs and fitting are as described in Chapter 4. Since Side-Winders are inserted occlusally, their arms will generally point mesially, the main exception being the second premolar in a first premolar extraction case (Fig. 18.6).

However, the degree of activation will need to vary according to the tooth and the root movement required. A Side-Winder needs to work harder to produce a combination of torque and tip, than tip alone. Incisors are most commonly the teeth requiring both, to which the full activation of Side-Winders, as supplied, is appropriate (Fig. 18.7). This may also apply to lower incisors, where bodily control may be required to boost anchorage, as is commonly practised with straight-wire appliances. On the other hand, with premolars

and canines, most of the required correction will be tip, seldom with much torque. Experience with the former Begg appliance demonstrated that simple tip correction could be obtained effectively with appreciably less activation than is provided by an Invisible Side-Winder straight from the packet.

Caution is therefore necessary to prevent activation in excess of requirements, particularly to canines and premolars, in which the arc of tip correction lies more along the buccal segment than across the arch. The reciprocal of distal root uprighting is forward crown movement, which represents loss of anchorage. Greater than necessary distal root activation on canines and premolars will therefore encourage a procumbent labial segment. A maximum of 45 degrees of activation between the spring arm and the archwire is quite sufficient (Fig. 18.8). This can easily be achieved by swinging the arm of the spring gingivally, somewhat past its fitting position, before hooking it on to the archwire.

Placing the modules last, the Straight Shooter requires positive placement to find the bracket beneath the spring. It needs a bit more of a push.

Removing the archwires

So long as the archwire ends were thinned lingually and annealed before insertion, removal should be no problem. First, it makes sense to straighten out the cinchbacks as much as possible with a Howe plier or similar. Once the ligatures have been removed, the archwire can then be withdrawn forwards with a light wire plier, working against the mesial contact point of the molar, much as described previously. Because a distal end can never be straightened perfectly, it will not slide forward through the tube freely. However, sweeping the plier handles gently forwards, along the long axis of the wire, as in Figure 18.4, will 'walk' the wire mesially out of the tube in three or four movements, without discomfort to the patient.

CHAPTER 19

Stage III checks

Absolute need to provide extra space	172
‘Hyperactivation’ of Side-Winders	173
The contrast with Plus	173
Causes of inadequate torque	174
Case 11 An adult Class I case with crowding treated with the Rx-1 bracket	175
Case 12 A severe Class II division 1 malocclusion with increased overbite on a very low mandibular angle Class II base treated with the Plus bracket	180

Stage III checks

The inspection interval in Stage III is approximately 2 months. As the entire torquing and tip correcting process is essentially built-in, and self-limits automatically, progress and maintenance checks are normally all that is required; it is unusual for an archwire to require removal, except for running repairs or possibly upgrading a deep tunnel auxiliary.

At each check visit, the following should be observed:

- **Progress of tip and torque.** Both proceed concurrently. A Tip-Edge bracket can be seen to have self-limited when its upper and lower surfaces lie parallel to the archwire (Fig. 19.1). Always assess the root angulations as well as the brackets. *Lack of progress is almost invariably due to inadequate mesio-distal space in the arch. It may also be due to incorrect bracket angulation, causing the bracket to self-limit before the desired root angle is achieved.* An advantage of Plus is that all bracketed teeth are maintained in torque and tip control until the last one is finished. There is therefore no temptation to remove springs from the teeth that look finished, while waiting for the rest. This used to allow some individual root relapse, before Plus.
- **Available space in the arch.** Except towards the end of root uprighting, it is essential to ensure that up to 1 mm of space exists somewhere in each arch (Fig. 19.2). As explained previously, premolar and canine crowns require additional arch length as they upright, and failure to provide this will stifle the action of the uprighting, whether with Plus or Side-Winders. The procedure for introducing extra wire from the back is described presently. *Tight or overlapping contacts are sure signs that a limited amount of extra space is needed to make further progress* (Fig. 19.3).
- **Unwanted space.** More than 1 mm of space is wrong, and should be gathered up by running an elastomeric E-link from crimpable hook to molar hook. At the following visit, the relevant distal arch cinchback will need to be tightened. *Excess space is caused by distal cinchbacks that are too slack.*

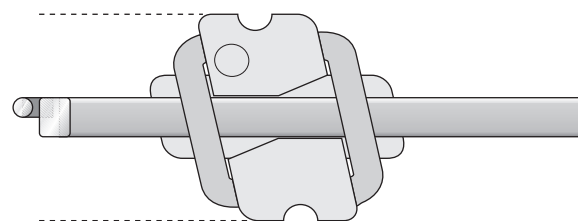


Fig. 19.1 A Tip-Edge bracket has fully expressed when its occlusal and gingival tie wings have become parallel to the rectangular archwire.



Fig. 19.2 A very small amount of space somewhere in the arch is necessary to allow freedom of uprighting, unimpeded by tight contacts.

- **Condition of the uprighting auxiliaries.** Distortion of nickel–titanium auxiliaries is seldom seen, since these are shielded by the main archwire. With Rx-1, Side-Winders are seldom lost, as they are retained by the elastic ligatures. However, the loops may become distorted labially, particularly if fiddled with by the patient, and should be bent back to correct shape or replaced. *A labially displaced loop can predispose to a small mesio-palatal rotation.*



Fig. 19.3 Tight contacts and anterior rotations (in this Rx-1 case) are indicative of inadequate space during root uprighting.

- **Activation of Side-Winders (Rx-1).** These normally hold their activation without adjustment. However, final torque delivery and apical definition on incisors may require additional activation. 'Hyperactivation' for this purpose will be described shortly.
- **Interarch relationship.** Is the patient regulating the elastic wear adequately to maintain incisor contact, when in the retruded centric position? *The possibility of adverse growth should be considered, but slippage of the interarch relationship almost always identifies a forgetful patient.*
- **The vertical relationship.** Is overbite reduction and buccal segment interdigitation being preserved? Relapse of overbite in Stage III will most often be the result of inadequate archwire bite sweeps. In addition, vigorous activation of canine Side-Winders can cause overbite increase and infraocclusion of first molars, by reciprocal tipping of the archwire. *This should obviously be avoided, but may require 'Class II check' elastics to rectify (Fig. 19.4).*
- **Molar widths.** These will be well controlled by the rectangular archwires. However, in cases where crossbite correction is continuing into Stage III, an archwire may possibly need removal to check width and further adjust, or cancel, active molar torque.
- **Second molars.** Towards the end of Stage III, the position and function of second molars will need assessment, with a view to alignment if required. This is outlined in the following chapter.



Fig. 19.4 Class II check elastics can be a useful aid in maintaining overbite reduction, or promoting molar occlusion.

- **Profile considerations.** This may require confirmation with cephalometric assessment. Is anchorage reinforcement required? *A less than ideal profile may be the result of adverse growth or an inappropriate treatment plan. Too procumbent a profile may also be provoked by excessive activation of Side-Winders, particularly on canines. This is not likely with Plus, using only a .014 inch tunnel wire.*

Absolute need to provide extra space

This is the most common adjustment needed during Stage III and takes only a few moments to perform. Except when premolar and canine uprighting is almost complete, a very small amount of free space should be available in each arch, to give the crowns the extra 'elbow room' they require as they upright.

The method used is very much the same as described under 'cinchbacks' in the last chapter. First, the four incisors should be released from the archwire by removing the modules. The tapered tips of a light wire plier should then be inserted in the contact mesial to the molar band, grasping the archwire immediately mesial to the buccal tube, before gently rotating the handles forward (Fig. 19.5). Only about half a millimetre of wire will need to be fed through from each side. This needs to be observed carefully. The easiest way to do this is to watch the crimpable hook; the slightest forward movement will be sufficient. The elastomeric modules can then be replaced, which will gather the incisors fractionally forward. During the early part of the third stage, and particularly in extraction cases, it is common to have to repeat this simple process at later visits.



Fig. 19.5 Admitting a small amount of extra space during Stage III, by feeding half a millimetre of wire forward through the molar tube. The incisor ligatures should be removed first.

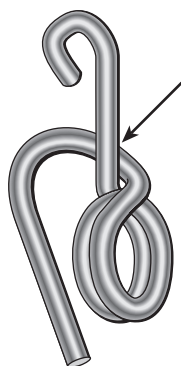


Fig. 19.6 It is not possible to increase Side-Winder activation by unwinding the coils, since the arm will be obstructed by the leg.

'Hyperactivation' of Side-Winders

This is included here for the benefit of Rx-1 users. It was described in the previous edition of this book as only ever required towards the end of treatment, on selected teeth. The aim is to facilitate the delivery of the final torque prescription, also to increase bodily control, where required, for anchorage purposes. In practice, this refers to incisors, almost exclusively. Never should springs be tweaked indiscriminately to speed treatment, particularly down the buccal segments. The outcome would be dragging of anchorage.

Taking a look at the design of a Side-Winder (Fig. 19.6) it will be seen that activation cannot be increased by bending the arm to open up the coils. This is because the leg of the spring crosses the arm and coils occlusally, to protect them, and therefore prevents the leg from being unwound to increase its activation. Instead, the square beak of a light wire plier should be placed within the coils, the round beak on the outside (Fig. 19.7). A single squeeze will then flatten a small section of the coils, effectively expanding them. The arm now actively presses against the leg and would spring past it, if it could.

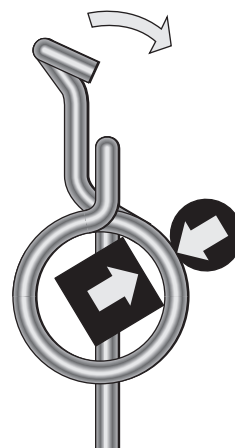


Fig. 19.7 A Side-Winder can be 'hyperactivated' by flattening a small section of the coils with a light wire plier, which effectively expands them (see text).

This adjustment can be made without removing the spring. The temptation to do it more than once at a time should be resisted, as excess activation can distort the spring, or cause it to unhook.

The contrast with Plus

Obviously a nickel-titanium uprighting wire cannot be 'hyperactivated' and lacks the facility for different degrees of activation to different teeth. Yet experience so far suggests that Stage III progresses at least as efficiently, with Plus, as it did with the former Rx-1 system. In fact, it often seems to be quicker. As yet, we do not know why, since force levels tend to be lower throughout, and particularly towards the end. However, referring back to Figure 3.13(a), it can be seen that the activation of the deep tunnel auxiliary is 'synergistic' between distally inclined brackets. This means that the deflection of the uprighting wire, caused by the angle of tip of each bracket, has an effect on the adjacent bracket. To this must be added the cant within the brackets of the deep tunnels themselves. So it is that the steep deflection of the wire between the central and lateral incisors augments the uprighting (and therefore the torquing) of both. Similarly a distally tipped lateral will help the canine and so on. This does depend on the case, however, and it could be argued that where two teeth are tipped towards each other, such as across a first premolar extraction space, the second premolar might subtract from the uprighting of the canine. Fortunately this does not seem to prolong the process clinically.

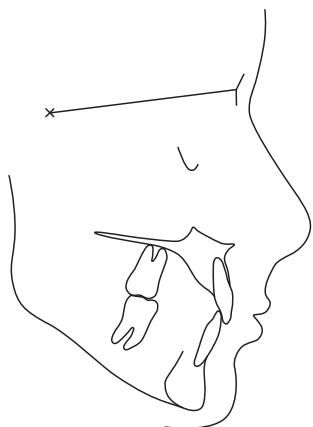
There can be less argument where anterior anchorage reinforcement is required. This might be indicated to prevent lower incisors becoming too proclined by Class II traction, for instance. If such a measure becomes necessary, it is of course possible to remove the uprighting wire and complete the case with Side-Winders.

Causes of inadequate torque

- **Incorrect bracket.** Use of a bracket designated for a different tooth will obviously have an inappropriate torque prescription.
- **Misangled bracket.** As with any straight-wire appliance, angling the brackets accurately up the long axis of the tooth is essential to a perfect finish. Angling the jig towards the distal will achieve corrected tip angulation before the bracket has self-limited. The torque will not therefore have been expressed.
- **Incorrect archwire.** Use of an undersized rectangular archwire will reduce torque response; an uprighting auxiliary needs the maximum archwire width to produce the torque efficiently.
- **Incorrect bonding position.** Placing a bracket too far incisally or gingivally can significantly alter the final torque angulation due to the buccal crown curvature.
- **Incomplete bracket engagement.** Even a small rotation will greatly reduce the efficiency of torquing. This may denote tight contact points. The risk of partial disengagement is reduced with Plus, in which the deep tunnel wire preserves alignment.
- **Wire ligatures.** Only elastomeric ligatures should be used. Stainless steel ligature ties will not readily adapt their shape to conform to angular changes between archwire and bracket, and will impede uptake of both tip and torque.
- **Tight contact points.** Cinching the archwire ends too tightly will produce tight contact points, denying the crowns the extra space they need to become correctly tipped and torqued, as explained previously.
- **Underperforming uprighting auxiliary.** Side-Winders will seldom be a problem unless lost or distorted, but a faulty deep tunnel wire is a possibility. A .014 inch wire is the minimum required for full expression of torque and tip.
- **Incorrect torque value in archwire.** It is generally better to set the torque in the archwire to over-torque slightly, rather than under-torque. Obviously, if a retroclined torque value is set in the archwire, the outcome will be a retroclined segment.
- **Late crown movements.** An uprighting auxiliary (spring or wire) will torque a stationary tooth to its intended prescription. If, however, a tooth crown is moved late in the torquing process, there will be a small delay while the auxiliary torques the root to catch up with its new crown position.
- **Tipped occlusal plane.** This is a significant one. It should be remembered that the torque prescription in each bracket is relative to the plane of the archwire. Therefore, if the occlusal plane is allowed to rotate clockwise during treatment (usually due to inappropriate use of Class II intermaxillary elastics or too high elastic forces) a correct torque value achieved between bracket and archwire will appear under-torqued facially.

Case 11

An adult Class I case with crowding treated with the Rx-1 bracket



SKELETAL		Pre-treatment		TEETH	
SNA	°	78.5		Overjet	mm 3.0
SNB	°	76.5		Overbite	mm 4.0
ANB	°	2.5		UI/MxP	° 103.0
SN/MxP	°	12.0		LI/MnP	° 82.0
MxP/MnP	°	28.0		LI-Apo	mm 1.5
LAFH/TAFH	%	52.0			

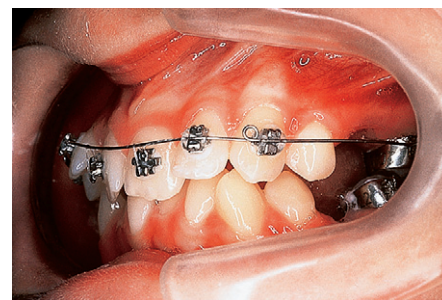
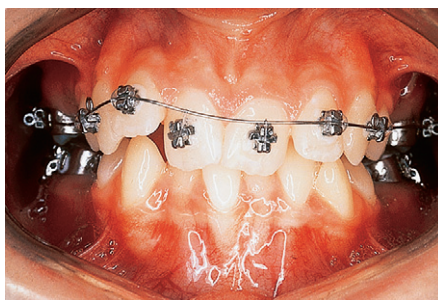
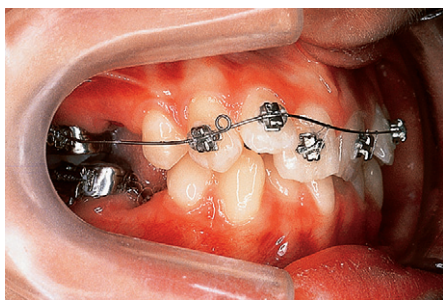
1

At 18 years 3 months, a non-growing adult with a relatively normal skeletal base, retroclined upper incisors and lower incisors just ahead of the A-Po line.



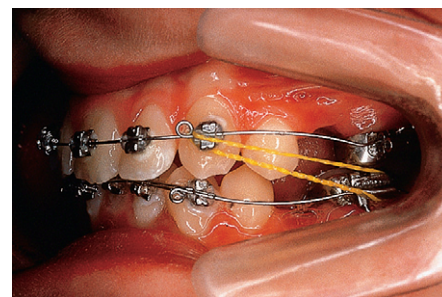
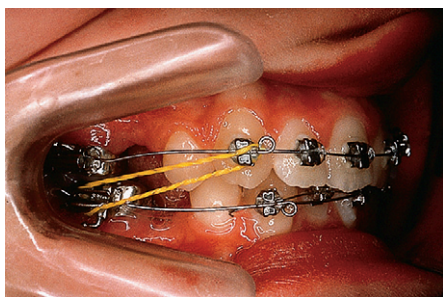
2

Upper and lower incisors are crowded, with some appearance of a Class II division 2 incisor relationship. However, the overbite is only slightly increased, and should not present a treatment problem. Four second premolars are designated for extraction.



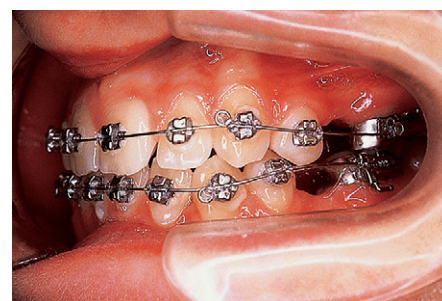
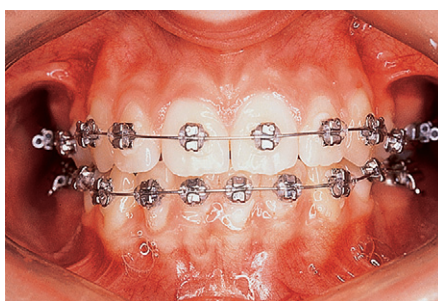
3

Unwanted opening of an adult mandible, which cannot respond with forward growth, should always be borne in mind. However, the small amount of bite opening in a near normal skeletal pattern is unlikely to cause posterior extrusion. Normal Tip-Edge Stage I mechanics are therefore appropriate. Firstly, the retroclined upper central incisors are advanced labially, using a .016 inch high tensile stainless archwire, to which the upper centrals are tied with elastic thread. Light tip-back bends prevent mesial migration of the upper molars.



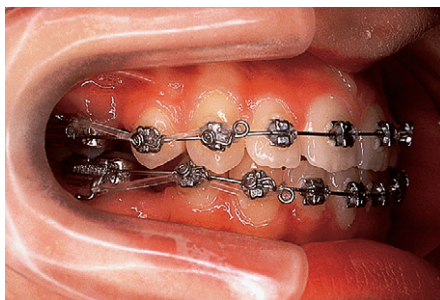
4

Two appointments later, both upper central incisors are fully engaged and clearance is available for lower bonding. Stage I begins, with 50 gram Class II elastics to a .016 inch high-tensile stainless archwire. Moderate anchor bends are placed mesial to all round molar tubes and the premolars are omitted to facilitate overbite reduction. A .012 inch nickel-titanium underarch is engaged to the instanding lower incisors.



5

Interincisor contact above the lower brackets indicates the end of Stage I. The premolars are bonded for alignment to the rectangular molar tubes, vertical bite sweeps replacing the anchor bends. The round tubes become redundant. Intermaxillary elastics are now only required occasionally, at nights, for the remainder of treatment, to preserve the interarch relationship.



6

Posterior anchorage is predictably stronger in the mature patient and, as anticipated, a considerable amount of extraction space requires to be closed in Stage II. Swept .020 inch stainless archwires with intra-arch E-6 elastomerics provide space closure. However, the labial segment position appears satisfactory, so that further retroclination is not required. Consequently, brakes are applied in all quadrants (distal root-moving Side-Winders boosting anterior anchorage on first premolars and canines) in order to protract the molars. Note the centreline discrepancy, which requires to be corrected before Stage III.



7

No centreline will correct while locked in place by bilateral brakes. Here, towards the end of Stage II, the upper centreline is to the right. Before all extraction space has closed, therefore, the brakes are removed from the upper left canine and first premolar, while continuing the four E-Links. This will allow retraction in the upper left quadrant, protraction elsewhere. The upper centreline will ease across to the left, aided by the brakes remaining in the upper right quadrant.



8

With the anterior segment positions well maintained by the brakes, Stage III has relatively little to do, particularly since the previous Side-Winder brakes have eliminated much of the distal crown tip in the canines and premolars. Archwires are .0215 × .028 inch stainless with vertical bite sweeps to retain overbite reduction. Choice of pretorqued archwires results in zero torque in both anterior segments, despite the sweep that would otherwise have caused proclination. With the Plus bracket, Stage III would use deep tunnel uprighting, rather than the display of springs.



9

Second molars need picking up more frequently in adult patients. Here, Rocke .016 inch sectionals (see Chapter 20) are providing preliminary alignment to the lower second molars, while Stage III nears conclusion elsewhere.



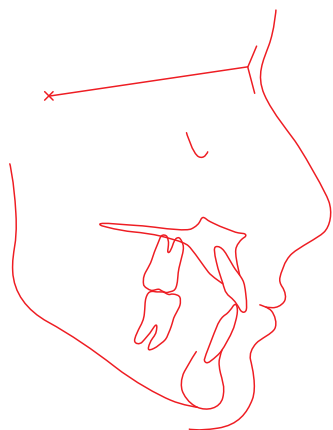
10

Detail alignment of the lower second molars is undertaken at the following adjustment with a .020 inch stainless archwire, converting the first molar tubes to brackets.



11

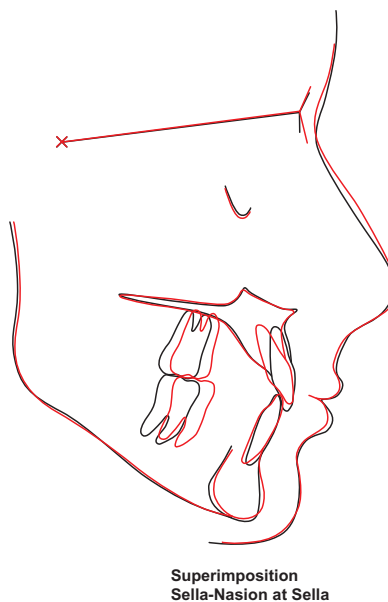
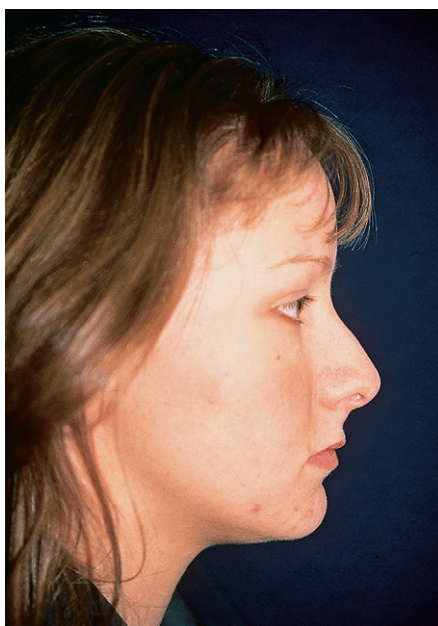
Including second molar alignment, Stage III has taken less than 6 months.



SKELETAL		Post treatment		TEETH	
SNA	°	77.5		Overjet	mm 3.0
SNB	°	76.0		Overbite	mm 2.5
ANB	°	1.5		UI/MxP	° 117.5
SN/MxP	°	12.5		LI/MnP	° 88.5
MxP/MnP	°	26.0		LI-APo	mm 2.0
LAFH/TA FH	%	51.0			

12

As in Case 5, the profile has been well preserved following extractions.



13

The improvement in appearance is largely dental. The upper incisors have been torqued 15 degrees. Note the superimposition of the cephalometric profiles and occlusal plane stability in the non-growing adult.

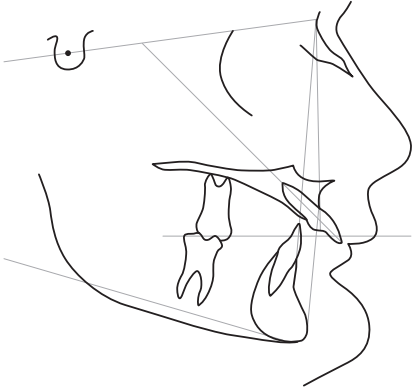
Treatment

Treatment time = 1 year 10 months.
 Routine adjustments = 13.
 Archwires used = 7 (3 upper, 4 lower).
 Retention = upper and lower Hawleys, nights only.

Case 12

A severe Class II division 1 malocclusion with increased overbite on a very low mandibular angle Class II base treated with the Plus bracket

Treated by Dr Christopher Kesling





Pre-treatment					
L1-APo	mm	-5.5	SNB	°	77.0
Wits	mm	+7.5	ANB	°	6.0
SN-MP	°	25.5	U1-SN	°	127.5
SNA	°	83.0			

1
By all appearances, at 11 years 10 months, a severe skeletal Class II case (Wits +7.5 mm and an ANB angle of 6 degrees) with a low mandibular angle, resulting in a reduced lower face height. However, the upper incisors are very proclined and the lower anterior segment is retroposed on mandibular base (5.5 mm behind the A–Po line), probably due to the adverse influence of lower lip trapping.



2
Both arches are somewhat spaced. The overjet is 10 mm and the overbite is increased. The buccal occlusion is towards Class II on both sides. Non-extraction treatment is clearly indicated here. Some proclination of the lower incisors can be expected to remain stable once normal lip function can be attained.

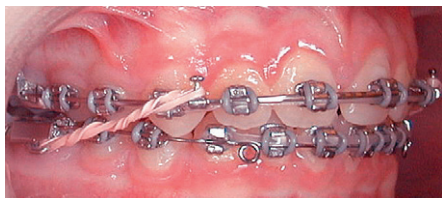


3
This is a classical non-extraction Stage I: .016 inch high tensile stainless archwires in round molar tubes will reduce the overbite with anchor bends, while light Class II intermaxillary elastics reduce the overjet. Plastic sleeves along all four buccal segments preserve the spaces for the premolars. These are not yet bonded, so that the intrusive effect of the anchor bends on the anterior teeth suffers no interference from brackets in the buccal segments.



4

In 7 months, the overjet and overbite have been corrected. The upper premolars are picked up for alignment to the rectangular molar tubes, using the existing Stage I archwire. Bite sweeps replace the anchor bends. The same adjustment was done to the lower at the last visit. Therefore the lower is now upgraded to an interim Stage II .022 inch stainless archwire. The centrelines are not yet coincident, but there is space available for their correction.



5

Stage III begins in the upper arch with a .0215 × .018 inch stainless archwire, having threaded the deep tunnels with a .014 inch nickel–titanium auxiliary uprighting archwire. An E-8 link is closing small anterior spaces, while a lower E-link gathers up the anterior spacing to correct the centreline along a .022 inch round stainless archwire.



6

Centrelines are now correct and Stage III is in full swing, with swept rectangular main archwires and .014 nickel–titanium in the tunnels.



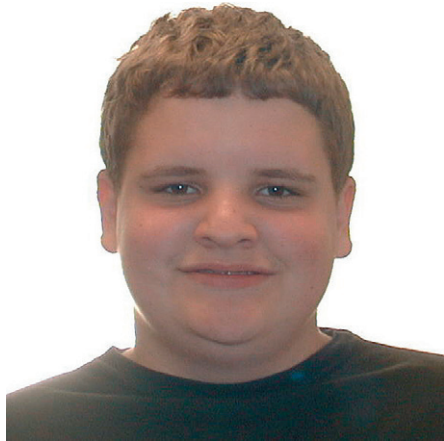
7

Appliances are removed after 5 months of root uprighting and an overall treatment time of 15 months.



8

There is a great improvement in profile and lip competence post-treatment.



Superimposition			
		Pre-treatment	Post treatment
		BLACK	RED
L1-APo	mm	-5.5	-1.0
Wits	mm	+7.5	+3.0
SN-MP	°	25.5	26.0
SNA	°	83.0	81.0
SNB	°	77.0	77.5
ANB	°	6.0	3.5
U1-SN	°	127.5	105.0

9

A clockwise growth pattern has been beneficial in this case, allowing some unfolding of the lips. The lower incisors have advanced almost up to the A-Po line.

Treatment

Treatment time = 1 year 3 months.
Routine adjustments = 9.
Main archwires used = 6 (3 upper, 3 lower).
Retention = Upper and lower removable retainers.

Precision finishing

Picking up second molars	185
Occlusal seating	186
Braided rectangular arches	186
Sectioning the main archwire	186
Crossbite cases	187
Positioners	187

As with any preadjusted appliance, Tip-Edge has an inbuilt ability to produce a self-limited precision finish. Moreover, in the hands of an experienced operator, it is capable of achieving such goals in considerably more difficult malocclusions than can normally be handled with conventional bracket systems. In this, it is worth stating the obvious, in that the proven intra-arch detail finishing, for which the straight-wire appliance is recognized, is wasted if a Class I interarch relationship cannot be achieved. This happens all too easily if the anchorage demands of the appliance exceed the co-operative abilities of the patient. With a light anchorage technique, this becomes much less likely.

Also, as with any fixed appliance, final detailing depends upon the accuracy with which the case is set up and it is towards the finish that previously unnoticed small errors in bonding come to light. Of these, incorrect bracket angulations can be corrected surprisingly easily during Stage III, without having to step down into a lighter archwire, so long as the tooth in question has not been allowed to 'over upright'. If it has, re-angling the bracket will result in an over-closed slot that will not accept the rectangular archwire. This may mean abandoning the deep tunnels and fitting a reverse Side-Winder for one visit, to undo the excess tip, before repositioning the bracket.

Assuming correct bracket and tube positioning, all that should be required during the brief finishing phase is occlusal seating; this is essentially the same as with straight-wire appliances. First, however, the second molars should be assessed for inclusion in the appliance.

Picking up second molars

Little has so far been said about second molars. This is because banding of second molars is very seldom required until late in treatment, in marked contrast to conventional appliances. Overbites reduce with only light intrusive forces, since the anterior teeth are not restrained apically. For this reason, the additional vertical 'leverage' afforded by second molars is not necessary. In fact, including second molars from the outset is more often obstructive, adding unwanted friction, particularly during the first and second stages. There may be rare exceptions

to this, however, such as in a deep bite non-extraction adult lower arch.

Routinely, as treatment nears conclusion, the second molars should be assessed carefully for alignment and function, including testing for non-working side interferences in lateral mandibular excursion. It will be found that lower second molars will require picking up more often than uppers, and most frequently in adults. Conventional straight-wire type $.022 \times .028$ inch second molar rectangular tubes are suitable.

Preliminary alignment can begin in late Stage III by means of a simple sectional device devised by Dr Tom Roche. While root uprighting is concluding elsewhere with third-stage rectangular archwires, a second molar can be aligned with a straight $.016$ inch high-tensile stainless steel sectional (Fig. 20.1). This is easily hand bent from a straight length with an annealed distal end. The sectional runs gingival to the first molar tube, lingual to the hook, and ends mesially with a small occlusally inclined loop. This hooks over the main archwire immediately mesial to the adjacent premolar bracket and should be squeezed closed for safety. The annealed distal end should be turned lingually for patient comfort. Such a simple sectional will improve alignment and correct mesial crown tip of the second



Fig. 20.1 A Roche sectional permits initial alignment of second molars while Stage III concludes elsewhere. It works equally well with Plus or Rx-1.

molar, but without disturbing the progress of Stage III elsewhere. Final alignment of the second molar will then entail a full archwire.

The choice of full archwire will depend largely on what is required elsewhere in the arch, as will shortly be outlined. Generally, second molar positioning is a matter of alignment only, for which a flexible round archwire will be appropriate. Rarely, however, a torque discrepancy between first and second molars may be apparent. If so, a rectangular nickel–titanium archwire will be appropriate, rather than an extended rectangular Stage III stainless archwire, which would be too heavy, acting between neighbouring molars.

Occlusal seating

Frequently an accurately set-up case will require no additional archwires beyond Stage III, unless the second molars are included. For a case that does require final seating, vertical elastics can be employed to a combination of molar hooks and gingivally inserted Power Pins, in conjunction with archwires of suitable flexibility. This normally involves no more than the final 3 weeks of treatment, the seating elastics being worn at nights only. With Plus, the deep tunnel uprighting wires should be removed to free the teeth up vertically.

Braided rectangular arches

These are inexpensive, yet effective for small vertical corrections. Archwire size is not critical, but $.019 \times .025$ inch is preferred (Fig. 20.2). If necessary, small vertical offsets can be

placed, to aid the vertical elastics in achieving a tight interdigitation. Care should always be taken to ensure strong cinchbacks, to prevent space from creeping in: 3 mm of distal projection, annealed, should be bent gingivally, hard against the molar tubes.

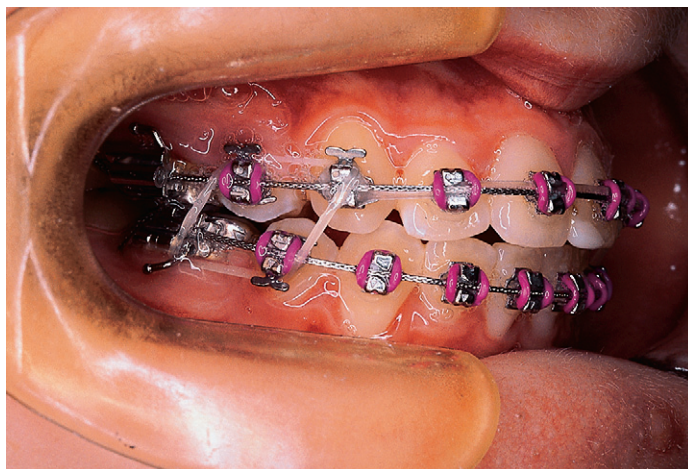
Neither Side-Winders nor conventional intermaxillary elastics should be used with multistrand archwires, for obvious reasons, although a short ‘rhomboid’ elastic configuration, in either a Class II or a Class III direction, can help maintain intermaxillary correction, as in Figure 20.2.

Sectioning the main archwire

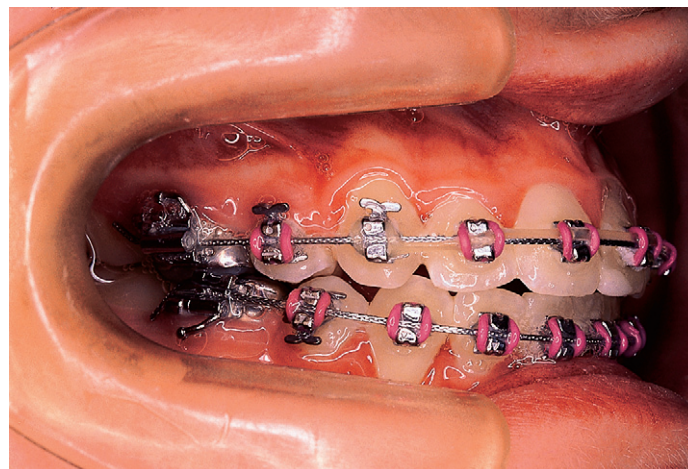
This is recognized practice with straight-wire, in one or both arches, and can be used with Tip-Edge too.

At the conclusion of Stage III, when all root uprighting is complete, the rectangular archwire can be cut distal to each canine. The molars, premolars and canines will then need tying together on each side with criss-cross ligature wire, to prevent spacing (Fig. 20.3). The anterior teeth will also need space prevention, conveniently provided by ligating the canine brackets around the hooks with elastomers, or running an E-9 elastomeric E-Link from canine to canine, as described in Chapter 8. In the absence of an archwire, triangular or rhomboid seating elastics to the buccal teeth need to be somewhat lighter, in order to avoid rotations.

It should be remembered that this method, while easy and apparently effective, preserves least control. In reality, it may be more prone to extrude the buccal cusps into a tight occlusion, producing a convincing final photograph, while leaving the palatal cusps unseated.



A



B

Fig. 20.2 $.019 \times .025$ inch braided archwires and seating elastics (A) promote a tight interdigitation 3 weeks later (B).

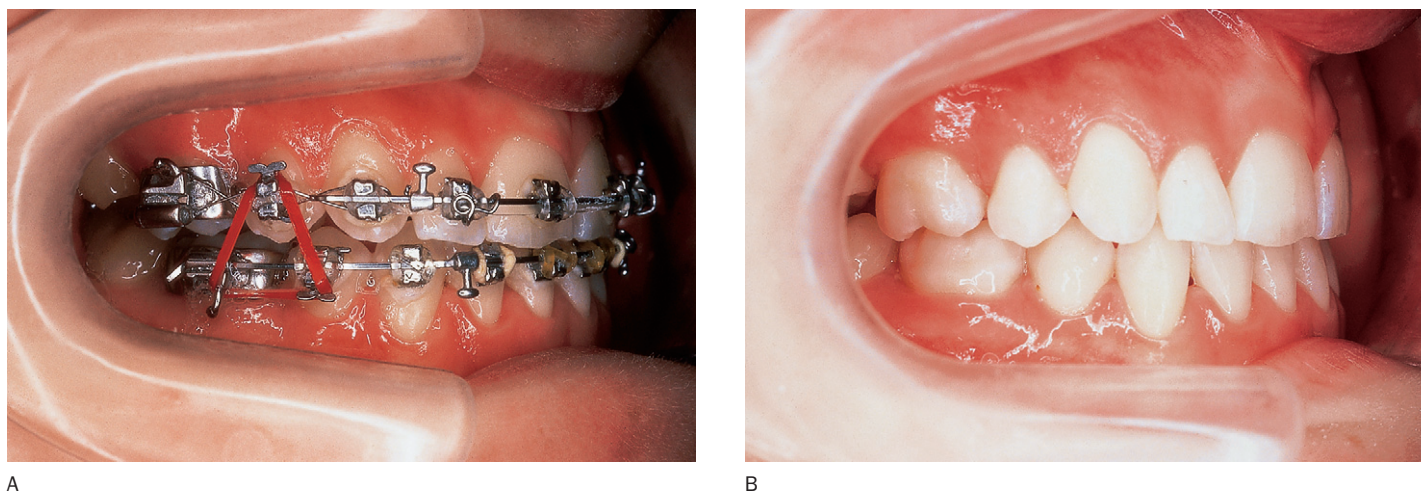


Fig. 20.3 Abbreviation of the upper archwire distal to the canines allows vertical seating of upper buccal segments. The canine brackets are laced back to the molars and the anterior units are prevented from spacing by an inconspicuous E-Link (size 9) from canine to canine (A). Night vertical elastics will seat the occlusion in approximately 3 weeks (B).



Fig. 20.4 A Pre-Finisher as a settling aid may take up to 6 weeks.

Crossbite cases

A problem with final 'flexi' arches, or deletion of the posterior segment, is lack of arch width control. This should be borne in mind when seating those cases in which the maxillary arch has undergone expansion, because vertical elastics with a flexible or abbreviated archwire will invite contraction of the upper buccal segments. It may be expedient to continue with the stainless Stage III archwire if possible, perhaps finishing the lower arch to the upper in such cases.

Positioners

The tooth positioner is becoming less frequently used in modern orthodontics, due to the improved finishing inherent in preadjusted systems. But it may sometimes avoid the need for finishing archwires, in correctly selected cases, by providing guidance

during natural settling. Pre-Finishers (Fig. 20.4) which come in a full range of different sizes (for premolar extraction and non-extraction cases), are particularly convenient, because they come ready made, unlike a true positioner. The downside of this is that they are inappropriate where individual tooth size discrepancies exist, such as small upper lateral incisors.

One problem in selecting the correct size of Pre-Finisher is that, in some countries, use of chemical sterilizing is no longer allowed. This prevents trying them for size in the mouth, which entails obtaining in-house models on which the appropriate size can be selected. Having said that, the extra inconvenience may be outweighed by a more accurate choice!

A positioner also requires a compliant patient, who can be relied upon to 'exercise' the teeth into it regularly, until longer term retainers can be constructed. Freedom from immediate laboratory arrangements is the main advantage of the Pre-Finisher, allowing a correctly selected patient to be debonded ad hoc, without the need for finishing archwires.

The non-compliant patient

Outrigger hooks	191
Case selection for Outriggers	193
Advantages of Outriggers	193
Limitations of Outriggers	193

The non-compliant patient

Like it or not, orthodontic treatment imposes a measure of discipline upon our patients. Isn't it an everyday fact of life that the more one puts in, the more one gets back? And so it is in orthodontics, both with ourselves and with each of our patients. However good the orthodontist, the result that will be achieved can be no better than the patient's co-operation allows. Successful orthodontic treatment must be the result of the orthodontist and the patient working together as a team, with mutual understanding and a trust in the capability and efficiency of the process.

Fixed appliances are in some respects the most demanding on patient co-operation, and attempts to produce a 'compliance-free' fixed appliance will inevitably be thwarted by the underlying reliance on the patient for prevention of bite damage and oral hygiene control. However, it obviously behoves the orthodontist to use appliances that are as easy as possible for the patient to use.

In this, Tip-Edge has fundamental advantages. Its initial speed of alignment cannot fail to impress the patient and parent and, being a light force and light anchorage appliance, it can reach its goals with intermaxillary elastics, rather than extraoral forces or implants, for the majority of even the most challenging Class II cases. The bracket itself is smaller and aesthetically superior to twin brackets, adjustment intervals are between 6 and 8 weeks and overall treatment times are generally reduced, dramatically so in major discrepancy situations.

Yet there will always be those patients who are careless or forgetful with their intermaxillary elastics. One ingenious solution to this problem is the use of Outrigger® (TP Orthodontics Inc., La Porte, Indiana, USA) hooks, invented in the late 1990s by Dr Christopher Kesling.¹ In carefully assessed cases, these may be strikingly successful in Class II treatment, although they do require to be used with considerable discretion.

Outrigger hooks

These automatically remind the patient to replace the elastics. They do so by the simple method of flicking out sideways, whenever the elastics are not attached. Each Outrigger appli-



Fig. 21.1 An Outrigger appliance.

ance consists of a pair of hooks, coiled on the end of an inter-connecting span. Originally formed from continuous .014 inch stainless wire, current Outriggers are made in .016 inch to reduce the risk of fatigue breakage (Fig. 21.1). Outriggers are supplied preformed in a range of sizes, according to the desired distance between the hooks. These should be sited between the lateral incisor and canine brackets, without making contact with either. The sizes are numbered in millimetres between the mesial of the two hook coils. In practice, this means measuring from the mesial of one lateral incisor bracket to the other and adding 2 mm.

There are two possible ways of fitting Outriggers, for which the reader is referred to the Tip-Edge Plus Guide for precise details.² When first described, the Outrigger shared the main archwire slots, and was threaded on from the back of the archwire, before fitting in the mouth. This method is still possible and has good aesthetics, but cannot be used with cuspid circles. This is a disadvantage as, without cuspid ties, the archwire must be stabilized by the less accurate method of cinching distal ends. Some other means (such as a long E-Link) must also be used to prevent anterior spacing.

Seating the Outrigger separately in the occlusal tie-wings of the upper central and laterals (Fig. 21.2) is currently favoured. For this purpose, the long redundant 'bilevel pin' has been revived from the earliest days of Tip-Edge (Fig. 21.3A). This, inserted occlusally up the vertical slot (Fig. 21.3B), retains just like a Power Pin, and converts the tie-wing into a horizontal



Fig. 21.2 An Outrigger retained by bi-level pins in the central and lateral incisors (Dr C. K. Kesling).

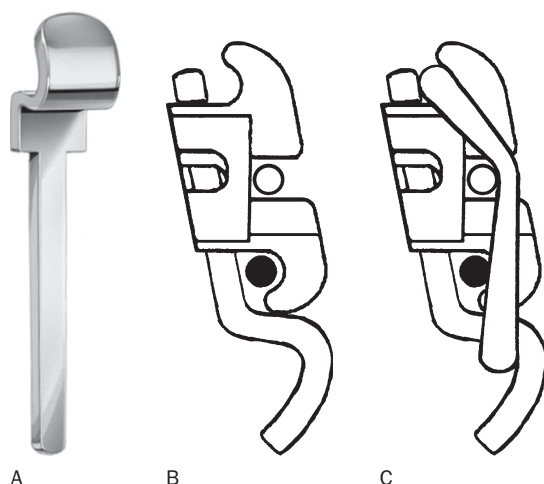


Fig. 21.3 (A) A bilevel pin. (B) Inserted occlusally up the vertical slot, the bilevel pin is retained by bending the gingival tail, like a Power Pin. It secures the Outrigger (black) in the occlusal tie-wing. (C) It also provides a tie-wing to retain the main archwire (white) with an elastic ligature.

channel in which the Outrigger can easily rotate. It also provides a substitute tie-wing for the main arch elastomers (Fig. 21.3C). Used this way, the Outrigger can be adjusted or changed independently of the main archwire. The 'double wires' at the front are conspicuous, but the hooks flip up and down more reliably and the main archwire can have cuspid circles in the usual way.

Before fitting, the amount of buccal 'spring' in the hooks can be tested, and if necessary adjusted, by altering the curvature of the interconnecting wire, relative to the main archwire as shown (Fig. 21.4). When the elastic is placed, the vertical component of force should rotate the hooks vertically downwards (Fig. 21.5) without exceeding the light forces (2 ounces or 50 grams)

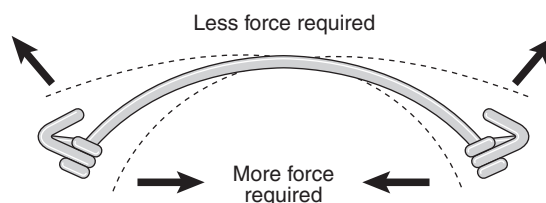


Fig. 21.4 'Tuning' the Outrigger: increasing the curvature increases the flick-out tendency and vice-versa.

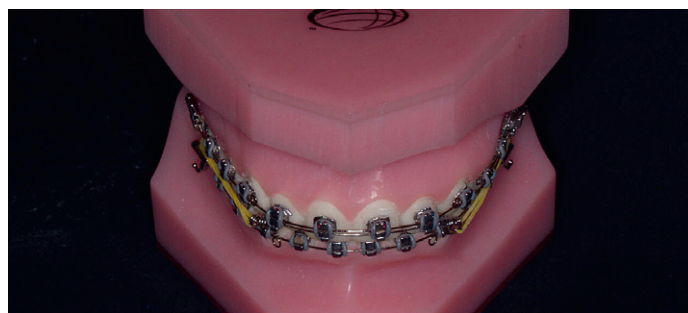


Fig. 21.5 With elastics in place, the Outrigger hooks lie vertically and are unobtrusive to the patient (Dr C. K. Kesling).

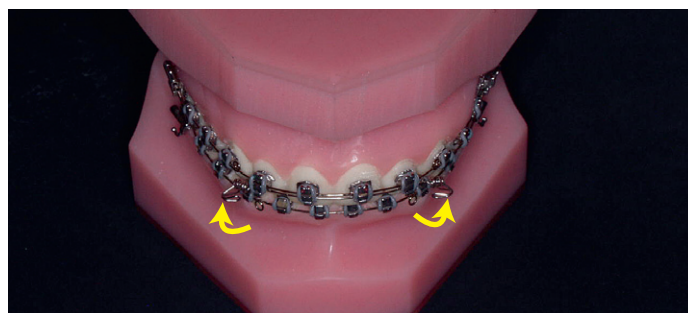


Fig. 21.6 Without the elastics, the hooks flick outwards as a reminder! (Dr C. K. Kesling).

prescribed. The curvature of the .016 inch Outrigger is also relevant to the main arch, now that both are of the same thickness. It may well be necessary to contract the main archwire across the front to counteract expansion of the canines and buccal segments. Also, to achieve a sufficient vertical component to rotate the hooks, it is sometimes necessary to wear the distal end of each elastic to the molar hook, rather than around the distal archwire end. Even though the force vector is not as favourable, it is arguably a lot better, in an unco-operative patient, than no elastic at all!

Whenever the elastic is released, the hook will spring out by up to 90 degrees (Fig. 21.6) causing some inconvenience to the upper lip.

Case selection for Outriggers

It is wrong to make any patient a prisoner to treatment. Outriggers should be seen as an aid to memory, rather than any form of compulsion. They are not intended to overcome the problem of the reluctant or rebellious patient, with that look in the eye that forewarns of wrecked appliances. However, they may prove extremely successful, by mutual agreement, in those individuals who mean well but who lack determination and find themselves forgetful. Parents may appreciate this, since it relieves them of constant vigilance and nagging.

Advantages of Outriggers

Quite simply, by ensuring complete elastic compliance, it comes as a revelation, to both orthodontist and patient, as to just how efficiently treatment progresses when intermaxillary elastics are worn literally all the time. Wasted clinical and treatment time is eliminated.

Limitations of Outriggers

- In malocclusions with anterior crowding or excessive incisor spacing, the introduction of Outriggers will need to

wait until the six anterior teeth are approximated and in alignment.

- The patient must carry an adequate supply of spare elastics at all times, for immediate replacement in the event of breakage or loss.
- Part-time wear is impossible. A patient needs to report in at once, in the event of a reversing overjet.
- Outriggers are not suitable for Stage III. Bi-level pins prevent the use of the deep tunnels or Side-Winders.
- Long-term fatigue fracture may occur. Renewal is therefore advised after 3 months in use.

In summary, the Outrigger is more relevant to Stage I than subsequently. This is less of a disadvantage than might be thought, since it is frequently only the first stage that requires maximum elastic wear. Maintenance of the incisor correction during subsequent stages seldom requires more than nightly elastic wear, or evenings and nights, hence placing fewer demands on the patient.

References

1. **Kesling CK.** A simple means of ensuring Class II elastic wear. *Journal of Clinical Orthodontics* 2000; 34:83–87.
2. *Tip-Edge PLUS Guide and the Differential Straight-Arch Technique*, 6th edn. TP Orthodontics, Inc. S1–27&28.

In conclusion

Orthodontists are always striving for improved standards. It is absolutely right that we should. Over the past 30 or so years, the emphasis has been on case finishing, stimulated perhaps by Andrews' straight-wire appliance more than any other. This, in turn, has spawned a whole plethora of alternative specifications along similar lines. Yet, the straight-wire concept is no more than a refinement (albeit a valuable one) of Angle's original thinking. Without argument, it does facilitate precision finishing compared with the previous detailing necessary with edge-wise archwires. But, granted that straight-wire may be the ultimate aligning appliance (which was what Angle designed his edgewise mechanism to be in 1925) it remains an inherently poor tooth mover in terms of translation over any distance. This limits its ability in treating both severe crowding and adverse interarch relationships.

To a great extent, modern orthodontic thinking has grown to accept these limitations. The increasing reliance on the maxillofacial surgeon and anchorage from implants cannot be ascribed simply to heightened patient awareness. It is, in no small part, a reflection of the limitations inherent in all edge-wise-based appliances. The more difficult the malocclusion, the more these limitations show up. With hindsight, might it not be said that, rather than focusing primarily on the finish, appliance development should have concentrated first on making the journey easier. For without completing the journey, there can be no successful finish. By way of analogy, an aircraft may boast a superb automatic touch-down facility, but this becomes irrelevant if the aircraft itself lacks sufficient range to reach the airport. In clinical terms, this equates to a malocclusion too difficult for an appliance to handle, or beyond the ability or willingness of the patient to co-operate to completion. It is a real world everyday challenge.

The cases that don't make it

Everybody knows that generally only the best case outcomes ever get presented, in which this book is no exception. Yet every honest orthodontist (this author included) knows that his office records contain a number of patients who will never be shown in meetings, still less published. Most of these will be improved, yet not perfect, while towards the bottom of the pile will be the frank failures, for which it may be expedient to blame the patient, sometimes justly. A contributory factor, however, may be an appliance less than equal to the malocclusion it has to treat, thereby over taxing co-operation. But,

whichever way we choose to look at it, this represents a big unseen problem which affects a great many patients.

Speaking personally, following many years of experience of difficult malocclusions using edgewise, Begg, straight-wire and Tip-Edge, it has been gratifying to see a markedly improved success rate with Tip-Edge, compared with any of its predecessors. It is also significant that where there have been shortfalls (usually when partial compliance has dictated a premature conclusion) these most often involve root uprighting or space closure. With straight-wire, it was frequently the more conspicuous residual overjet that persisted, due to the relative difficulty in reducing overbites, combined with heavy anchorage which, in my hands, proved to be the Achilles heel of the appliance. Treatment times were also longer.

Certainly, with straight-wire, the coming of nickel-titanium in its various forms has made the journey easier, both for the orthodontist and the patient, while self-ligating brackets remove some friction from edgewise-derived systems. Yet, all such appliances persist in moving teeth bodily which, as many years of orthodontics should have taught us, is the most difficult way to translate teeth. Put simply, our teeth have been telling us this for generations. Why have we not listened?

The 'philosophy' behind Tip-Edge Plus

So it is that the modern orthodontist should be confronted with a serious question. Why is it still accepted practice to work towards finishing angulations from the moment of first arch-wire engagement? The answer has to be that the straight-wire bracket dictates this. In so doing, by Tip-Edge standards, each tooth becomes an anchorage unit, without choice. As a clinician, Dr Edward Angle himself must have been aware of this, but at that time he disbelieved in mesio-distal translation of teeth, in favour of expansion. Also, Angle had no ready means of recovery from tipped angulations. Without doubt, Tip-Edge is with us to challenge the established view, and Plus does so more efficiently. Even though it requires a steep new learning curve to depart from convention, the results demonstrably expand the horizons of fixed appliance capability beyond expectations.

To revert to the aircraft analogy, landing wheels are not required during flight. They fold away to make the journey easier, but become vitally necessary when landing. If taking up finishing angulations early in treatment makes the journey more difficult, the philosophy behind Tip-Edge makes obvious

sense: finishing angulations, by their very definition, do not become necessary until the finish of treatment.

Looking back, looking forward

Looking back, as now I must, over my own career, it was the Begg technique that showed me just how fast and how easily teeth could be moved by differential tooth movement. It was, however, fraught with risks for the inexperienced and difficult to control. It also lacked an inbuilt finishing ability. Straight-wire, on the other hand, set new standards for case finishing, to which we all had to aspire. It was an obvious career ambition, therefore, to try to combine the ease of tooth movement of the Begg appliance with the precision finishing of modern straight-wire. The Tip-Edge bracket, uniquely, has allowed me to achieve this.

So what of the future? The manufacturers of Plus (TP Orthodontics) claim it to be 'the next direction in straight-wire.' Is this likely? In terms of the original concept of straight-wire, Tip-Edge with rectangular wire can truly claim to be a straight-wire appliance or better, in that it produces a zero tolerance finish with no torque slop. There is, therefore, no requirement to individualize the finishing archwires. However, the term 'straight-wire' will for ever be associated with edgewise derived bracket systems. Nevertheless, in the materials and methods used to gain the final result, it is interesting to see the two techniques coming closer together than ever before. The main difference now is the treatment sequence. Straight-wire begins by levelling and aligning, generally using nickel-titanium wire, then subsequently translating the teeth by bodily movement. Plus reverses the order by translating the crowns first, allowing them to tip with very light forces, before uprighting each root individually to its finishing position. Both techniques now employ nickel-titanium archwires for root uprighting.

The concept of 'Plus' is undeniably attractive and is already appealing to a wider user base than its predecessor, particularly now that it is available with ceramic brackets. Although it shows considerable clinical promise, it must be remembered that, while Tip-Edge is thoroughly proven clinically, the Plus bracket is relatively early in its development. However, there is no doubt that it offers great potential for the future of orthodontics.

The economics of Plus

A common mistake, made universally it seems, is to assess the cost of an appliance by its outlay rather than its efficiency. This is understandable. As the orthodontist pays his monthly expenses, he or she will be aware that Tip-Edge is appreciably more expensive to purchase than straight-wire systems. However, the really expensive item in the treatment of any case

is actually the orthodontist's office time, which will be less noticed, unless recorded and measured. So the over-riding question is whether the performance of Tip-Edge Plus improves sufficiently over conventional appliances to justify its additional purchase price. To this must be added the inconvenience of switching to a different set of molar bands and learning a new technique.

Unfortunately, but inevitably, new skills worth having take time to acquire. This being so, immediate cost effectiveness cannot be expected to prove favourable. A fair comparison can only be made in the hands of the same operator, and not before the same degree of familiarity has been gained with Tip-Edge Plus as with the previous technique. More convincing, early on, will be the patient's appreciation of rapid early tooth movement and facial change, without needing to wear headgear, or being subjected to implants or functional appliances as a prior procedure. Once the operator has become fully proficient with the appliance, however, the gains will be considerable. Financially, these will be most convincing in the more difficult cases. Only in simple alignment cases with minor irregularity will Tip-Edge show no advantage.

But the gains to the orthodontist and patients surely require to be measured on a wider scale than monetary yield alone. When the orthodontist becomes capable of treating more difficult malocclusions than his more conventional colleagues, professional pride of performance is most meaningfully enhanced. This will extend to all members of the orthodontic team. Furthermore, if such results can be achieved over a shorter timespan and with less co-operation required from the patients, positive feedback is sure to bring its own rewards. There is true satisfaction in a difficult job well done.

Starting from scratch

'Gently does it' must be the rule. A hands-on course is recommended, which gives the opportunity for familiarization with the handling of the appliance before starting on patients. It takes time to 'get the feel' of any new technique, particularly one that is as different as this! However, at least Plus is convincingly easier to use, if harder to learn. Instead of having to drive the teeth to their new positions, as with bodily movement, teeth and segments of teeth 'flow' with Tip-Edge, as if naturally. Be sure to keep all elastic forces light, therefore, compared with what you have been using previously. The appliance is very responsive, like a sports car, and does not need a heavy hand.

It is advisable to begin with cases of only medium severity, so that confidence can be gained swiftly. Moderate crowding, overjets within 9 mm and overbites that are increased, but not traumatic, can be handled with surprising ease, before going on to tackle difficult cases that other appliances cannot routinely manage.

Because Tip-Edge has a number of treatment options outside the range of the ordinary, such as Power Tipping, bracing and

the different modes in which it can be used, it is, and always will be, a technique for the thinking orthodontist. There is no cook-book recipe in its treatment progression and the order in which it treats the various features of the malocclusion will be the opposite of the familiar. In this, it is greatly helpful to keep rigidly to the prescribed three treatment stages, completing the objectives of each stage before moving on to the next. Mixing the stages is one of the commonest mistakes made by the beginner, leading to confusion and time lost in the treatment.

Experience gained in lecturing and giving courses around the world has taught me much! Orthodontists tend to be a con-

servative bunch, reluctant to depart from the ways they have been taught, even when they see something demonstrably better than what they are using. Extreme enthusiasm, so often seen at the end of a course, tends to be somewhat blunted by the following Monday at the office. Then the prospect of treading into the unknown seems suddenly more daunting. Anything worth gaining needs commitment and any reader who has persevered this far must surely agree that Tip-Edge Plus deserves this. Once into the technique, its possibilities are immense and there can be no turning back.

That is why I have written this book.

Tip-Edge treatment sequence

Stage	Functions	Archwires	Technique	Adjustment interval
I	Alignment of upper and lower anterior segments Closure of anterior spaces Correction of increased overjet or reverse overjet Correction of increased overbite or anterior open bite Begin buccal segment crossbite correction	.016 inch high tensile stainless .014 inch nickel–titanium underarches to align instanding anteriors	Omit premolars if overbite increased (in which case use round molar tubes) Intermaxillary elastics and anchor bends as required E9 E-link to close anterior spacing Ligate canine brackets to cuspid circles once anteriors aligned	6 weeks
End of Stage I	Bond premolars if initially excluded (increased overbite cases) and align to rectangular molar tubes	Continue .016 inch high-tensile stainless	Remove anchor bends and wipe in vertical bite sweeps Replace archwires in rectangular molar tubes Continue canine to cuspid circle ligation until Stage II Continue traction as necessary to maintain incisor contact	3 weeks
II	Closure of residual spacing, by retraction or by protraction Correct centrelines Continue crossbite correction Maintain Stage I corrections	.020 inch high tensile stainless (option of .022 inch in first molar extraction or crossbite correction cases)	Rectangular tubes; bite sweeps if required Horizontal E-links for space closure Brakes if protraction necessary Unilateral brakes for centreline correction Continue traction as necessary to maintain incisor contact	6 weeks
End of Stage II	Derotation of first molars Levelling of first molars if necessary	Continue with same	Offsets and toe-ins to first molars following space closure Consider anti-tip bends to seat distal first molar cusps	3 weeks
III	Correction of torque and tip angles Attainment of optimal facial profile Maintain Class I occlusion	.0215 × .028 inch stainless (for choice of plain or pretorqued see Ch. 16) .014 inch nickel–titanium deep tunnel auxiliary	(Cephalometric X-ray first) Rectangular molar tubes. Thread deep tunnels (or place Side-Winders). Consider anterior torque modification in Class III cases (see Ch. 16) Continue traction as necessary to maintain Class I occlusion	2 months
End of Stage III	Assess need to include second molars Final detailing, seating, etc	.016 inch sectional Rocke sectionals ? free the buccal segments from main archwire ? .019 × .025 inch braided	For preliminary alignment of second molars to first molars Vertical seating elastics, nightly, to Power Pins and/or molar hooks (Consider Pre-Fit positioner – see Ch. 20)	3 weeks

Further reading

- Cronin T.** Arch wire sequencing in Tip-Edge treatment. *Journal of General Orthodontics* 2001; 12:31–33.
- Harrison JE.** Early experiences with the Tip-Edge appliance. *British Journal of Orthodontics* 1998; 25:1–9.
- Kesling CK.** Improving incisor torque control with nickel titanium torque bars. *Journal of Clinical Orthodontics* 1999; 33:224–230.
- Kesling CK.** Case report: Tip-Edge treatment of a Class II division I malocclusion with an anterior open bite. *Journal of General Orthodontics* 1992; 3:19–22.
- Kesling PC.** *Tip-Edge Guide and the Differential Straight-Arch technique*, 4th edn. Two Swan Advertising; 2000.
- Kesling PC, Roche RT, Kesling CK.** Tip-Edge brackets and the Differential Straight-Arch technique. In: Graber TM, Vanarsdall RL, eds. *Orthodontics current principles and techniques*. St Louis: CV Mosby; 2000.
- Kift RJ.** Non-extraction Tip-Edge appliance management of a moderate Angle Class II division 1 malocclusion commenced in the late mixed dentition. *Australian Orthodontic Journal* 2001; 17:47–54.
- Knight H.** The effects of three methods of orthodontic appliance therapy on some commonly used cephalometric angular variables. *American Journal of Orthodontics and Dentofacial Orthopedics* 1998; 93:237–244.
- Lawson R, Durning P.** Use of Tip-Edge brackets in patients with repaired alveolar clefts. *Journal of Clinical Orthodontics* 1998; 32:84–88.
- Miyajima K, Iizuka T.** Treatment mechanics in Class III open bite malocclusion with Tip-Edge technique. *American Journal of Orthodontics and Dentofacial Orthopaedics* 1996; 110:1–7.
- Morein S.** Tip-Edge challenges older appliances. *Journal of General Orthodontics* 1996; 7:6–11.
- Morein S.** Delayed extraction options with Tip-Edge technique. *International Journal of Orthodontics* 2007; 18:21–25.
- Pancherz H, Löffler A, Obijou C.** Efficiency of root torquing auxiliaries. *Clinical Orthodontic Research* 2001; 4:28–34.
- Parkhouse RC.** Differential tooth movement in ‘uphill’ cases. *American Journal of Orthodontics and Dentofacial Orthopedics* 1992; 101:491–500.
- Roche RT.** Employing Tip-Edge brackets on canines to simplify straight-wire mechanics. *American Journal of Orthodontics and Dentofacial Orthopedics* 1994; 106:341–350.